THE PREHISTORY OF THE TEHUACAN VALLEY

Richard S. MacNeish, General Editor

VOLUME FOUR

Chronology and Irrigation

Richard S. MacNeish, Frederick Johnson, Karl A. Wittfogel,
Richard B. Woodbury, James A. Neely, Gorgonio Gil Huerta, and Eva Hunt

"From a technical point of view, the Tehuacan Valley project was a monumental effort . . . This is the only project in all of Mesoamerica which provides us with a detailed history of technology, subsistence, and settlement patterns from the beginnings of human occupation to the present."—*Science.*

Volume Four of *The Prehistory of the Tehuacan Valley* covers two specialized aspects of the Tehuacan Archaeological-Botanical Project. The first part details the results of the Tehuacan Chronology Project, inaugurated and directed by Frederick Johnson and carried out under the aegis of the Tehuacan Project. Systematic selection and measurement of samples resulted in the determination of 218 radiocarbon dates. This radiocarbon chronology covers the range of time in the Tehuacan sequence from the early Ajuereado phase (8,000 to 10,000 years ago) to the close of the Venta Salada phase and the arrival of the Spanish in the sixteenth century. In addition, utilizing some 400 radiocarbon dates, a chronology for all of Mesoamerica is presented. This grew out of the application of the radiocarbon chronology to the vast amount of cultural and biological data gathered under the parent project. A complicated system of cross-dating resulted in a correlation of the Tehuacan chronology with about 145 complexes from eleven neighboring regions. Tables present the chronology in detail. Dr. Johnson, who co-authored this section with Dr. MacNeish, also served as editor of this volume.

The second part of the volume, dealing with irrigation, begins with a prologue by Dr. Karl A. Wittfogel. His "Hydraulic Approach to Pre-Spanish Mesoamerica" eloquently outlines the history of the theory of hydraulic society and its role in the development of high civilizations. This theory is broadly applied to the New World. Dr. Wittfogel is professor emeritus of Chinese History and director of the Chinese History Project at the University of Washington.

The section entitled "Water-Control Systems of the Tehuacan Valley" presents the first intensive archaeological study of irrigation over a 1500-year period for any area of Mesoamerica and makes available at last crucial data for the understanding of the all-important relationships of the development of water-control systems and the rise of civilization in this nuclear area. This pioneer work by Richard B. Woodbury and James A. Neely is amply illustrated with maps, drawings, and photographs. Dr. Woodbury is chairman of the Department of Anthropology at the University of Massachusetts; Dr. Neely is assistant professor of anthropology at The University of Texas at Austin.

The significance of the inseparability of land and water rights is demonstrated in the "History of the Foundation of the Town of San Gabriel

(Continued on back flap)

Digitized by the Internet Archive
in 2015

https://archive.org/details/prehistoryoftehu04tehu

THE PREHISTORY OF THE TEHUACAN VALLEY

VOLUME FOUR

Chronology and Irrigation

Edited by Frederick Johnson

Published for the

ROBERT S. PEABODY FOUNDATION

Phillips Academy, Andover

UNIVERSITY OF TEXAS PRESS • AUSTIN & LONDON

Published in Great Britain by the
University of Texas Press, Ltd., London

International Standard Book Number 0-292-70155-1
Library of Congress Catalog Card No. 67-17873
Copyright © 1972 by the University of Texas Press
All rights reserved

The preparation and publication of
The Prehistory of the Tehuacan Valley
has been assisted by grants from
the National Science Foundation.

Typesetting by Southwestern Typographics Inc Dallas, Texas
Printing by The Meriden Gravure Company, Meriden, Connecticut
Binding by Universal Bookbindery, Inc., San Antonio, Texas

EDITOR'S PREFACE

This fourth volume of the series that is concerned with the prehistory of the Tehuacan Valley discusses two somewhat specialized but by no means isolated aspects of the account of cultural development in the valley. The combination of the two, chronology and irrigation, is fortuitous and came into being simply because of timing and in order to solve a practical problem in book making. We apologize to the authors for the unfortunate but unavoidable delay in publication. Johnson and MacNeish's chapter was finished in 1968; Woodbury and Neely's in 1968; Hunt's in 1969; and Wittfogel's in 1970. The length of time between submission and publication is deplorable but nothing has appeared to modify significantly the information presented.

As the first season's field work in Tehuacan progressed the need for a detailed chronological control of a deep stratigraphic column became imperative. In view of this, Johnson organized a special project designed to provide a radiocarbon chronology covering the span of time estimated, in 1961, to be between 8,000 and 10,000 years. The Division of Social Sciences of the National Science Foundation, under the leadership of Allan Smith and later Richard Lieban, generously supported this project. Our ambition was to establish a chronology supported by as much detail as possible and controlled by a degree of precision limited only by the normal errors inherent in the samples and their measurement. There was nothing new about the application of radiocarbon dating except the number of determinations involved. The methods of collecting and recording the samples were devised in the hope that consistency in sampling could be maintained. In order that levels could be dated with confidence, sites that had clear and definite stratigraphy were excavated for the single purpose of collecting precisely located samples. The analysis of the data was done in Tehuacan and Andover by Dorothy and Frederick Johnson. The results of this are found in the second section of the chapter.

The second part of the analysis presents a chronology for all of Mesoamerica that grew out of the application of the radiocarbon chronology of MacNeish's analysis of the biological and cultural data, especially the ceramics. Even though Johnson's name appears rather prominently, his function was merely to help select and organize the radiocarbon chronology and to collate this with the cultural sequence derived from an almost overpowering assemblage of stratigraphically excavated and cross dated material produced by MacNeish. This data could not have been gathered together or put down in any comprehensible order if it had not been for the cooperation of practically every living archaeologist who has worked in Latin America and, to a slightly more limited extent, in "neighboring" regions. We refrain from listing these major contributors to our project because such a roster would repeat our bibliography. We offer these people our heartfelt appreciation for the way in which they have joined in the often spirited discussions. There are times when we have disagreed with the opinions of these colleagues, but in having the temerity to present our own deductions we also accept the responsibility for what may seem to some to be mistakes. The result of all this is, we hope, that the study will be a step forward in the understanding of the chronology of the region.

The study of irrigation in the valley arose because there was need to describe the mass of features resulting from prehistoric as well as historic irrigation which comprise such a large part of the landscape. The chapter by Richard Woodbury and James Neely was organized and designed for this purpose. Robert and Eva Hunt, passing through the valley on their way to and from the Cuicatec, could see implications in their own work with modern, neighboring peoples that were important to an understanding of prehistoric, protohistoric, and even modern cultural development. Discussion during visits to our field headquarters resulted in the chapter by Eva Hunt. It was our great good fortune to have Karl Wittfogel consent to write an introductory commentary on the whole problem. This, from a man who has spent much of his long and distinguished career considering the effects of irrigation on civilization, provides an important background for the other two chapters. To say that we are indebted to these authors for their discussions of the problems at hand is to express our feelings much more mildly than is the fact. More than that, the editor is personally grateful for the tolerance and forbearance which these authors so graciously exhibited. Rewritten passages have been received with a minimum of comment, and suggestions intended to improve the work have been enthusiastically considered. The volume has profited by this amiable cooperation. It is to be hoped that the authors realize that putting the book together has been a most pleasant experience. We must pay tribute to Mrs. Diana Cleveland who initially protested that she was nothing but a copy editor. Her work has gone far beyond that, for her attention has frequently been responsible for major improvements in the text. Problems inevitably arise in a situation where one serves as editor and at the same time collaborates with one man; in this case, the man who alone is responsible for the whole endeavor in Tehuacan. MacNeish occupies the roles of boss, colleague, collaborator, and friend with the greatest felicity. The experience of working with him and for him has been a most rewarding one.

FREDERICK JOHNSON

Andover, Massachusetts
May 1971

CONTENTS

Editor's Preface v

CHRONOLOGY

1. Chronometric Dating 3
FREDERICK JOHNSON AND RICHARD S. MACNEISH

IRRIGATION

2. The Hydraulic Approach to Pre-Spanish Mesoamerica 59
KARL A. WITTFOGEL

3. Water Control Systems of the Tehuacan Valley 81
RICHARD B. WOODBURY AND JAMES A. NEELY

4. History of the Foundation of the Town of San Gabriel Chilacatla . . . 154
GORGONIO GIL HUERTA

5. Irrigation and the Socio-Political Organization of Cuicatec Cacicazgos . . 162
EVA HUNT

Bibliography 261

Index 275

ILLUSTRATIONS

1. Map of the Tehuacan Valley 8
2. Radiocarbon dates on zones in the Tehuacan Valley 10
3. Chronology of zones in stratified sites 12
4. Mesoamerican regional sequences and accepted radiocarbon dates . . . . *following* 40
5. Map of vicinity of Purron Dam complex 82
6. South End of Purron Dam 84
7. Purron Dam 85
8. Longitudinal and transverse sections of dam 86
9. Plan of Purron Dam and associated structures 87
10. The south end of Purron Dam 87
11. Masonry of downstream face of Tr 15 88
12. Exposed cross section of Tr 15 88
13. Spillway in Tr 15. 89
14. Sketch map of Tr 447 100
15. Remnant of dam Tr 446 102
16. Rio Xiquila 103
17. Map of lower portion of Rio Xiquila 103
18. Masonry of the Xiquila aqueduct 104
19. Masonry of the Xiquila aqueduct 105
20. Portions of Xiquila aqueduct 105
21. Xiquila aqueduct 106
22. Terrace to support Xiquila aqueduct 106
23. Modern diversion dam on Rio Xiquila. 107
24. Upstream end of modern diversion dam on Rio Xiquila 107
25. Modern diversion dam on Rio Xiquila 107
26. Modern irrigated fields along the Rio Xiquila 109
27. One-room structure adjacent to aqueduct at Tr 405 110
28. A hillside farming site, Tr 332, based on field sketch 114
29. Farming site on hill flank adjacent to Tr 322, based on field sketch. . . 114
30. A wall at farming site Tr 322 115
31. Farming sites in Tecorral Canyon, based on field sketch 115
32. Farming terraces (Tr 314-north) 116
33. Farming terraces (Tr 314), based on field sketch 117
34. Terrace walls at farming site (Tr 314-north) 117
35. Farming terraces (Tr 313), based on field sketch 118
36. Sketches of "run-off boxes" at Tr 313 118
37. The uppermost boulder terrace of Tr 313 118
38. Row of boulders at Tr 313 118
39. Boulder lines at Tr 317, based on field sketch 119
40. Boulder lines at Tr 330, based on field sketch 119

41. Boulder lines at farming site Tr 414, based on field sketch 120
42. Sketch map of boulder terraces at Tr 418 120
43. Boulder terraces of farming site Tr 418 121
44. Boulder terrace at farming site Tr 418 121
45. Modern "field houses" north of Pueblo Nuevo 121
46. Modern "field house" north of Pueblo Nuevo 121
47. Field systems southwest of Zapotitlan, traced from air photos 122
48. Portion of air photo for Fig. 47 (D) 123
49. Boulder borders at Tr 423 123
50. Farm terraces at Locality 4 of Fig. 47 (B) 123
51. Map of ancient canal systems of the Tehuacan Valley 126
52. Fossil canal descending Altepexi Scarp near Tr 240 127
53. Fossil canal near El Riego 129
54. Detail of canal shown in Fig. 53 129
55. Cross section of one of the smaller canals (Tr 394B) 130
56. Travertine deposited on rim of canal (Tr 394A) 132
57. Small fossilized ditch with notched sides 133
58. A field near El Riego 133
59. Modern irrigated fields south of Texcala 134
60. Modern irrigated field at southeast edge of Tehuacan 134
61. Cleaning a modern irrigation ditch 136
62. An old ditch with new smaller channel (Tr 394C) 137
63. Modern canal near Chilac 137
64. Map of chain well systems of the Tehuacan Valley 138
65. Air view of chain well system 397 139
66. Air view of chain well system 407 140
67. Shafts of chain well system 395 140
68. Sketch of temporary platform and windlass 141
69. Top of well-maintained chain well shaft, system 394 143
70. Steps cut into sides of a chain well shaft, system 397 143
71. Initial chain well shaft in system 397 145
72. Debris around a freshly cleaned chain well shaft, system 427 146
73. Underground channel, chain well system 427 146
74. Map of Cuicatec language areas 167
75. Map of Cuicatec cacicazgos and some neighbors 170
76. Glyphs of Cuicatec towns 172
77. Glyphs of Atlatlauca 174
78. Glyph of Xayacatlan 174
79. Glyphs of Cuicatlan 176
80. Glyph of Papalotecpan 178
81. Glyph of Papalo 178
82. Examples of changes of political authority . . . . . *following* 180
83. Glyphs of Tepeucila 180
84. Glyph of Quiotepec 181
85. Glyph of Quiotepec 181
86. A page from the Codice de Quiotepec y Cuicatlan 182
87. Glyphs of Teutila 183
88. Glyph of Teotilalpan 184
89. Archaeological survey of Cuicatlan 1963 186
90. Warfare at the site of a water spring 187
91. Man-made water fountains 188

92. Warfare over a water spring 209
93. Warfare over a water spring 209
94. Warfare at a river location 210
95. Warfare at a river location 210
96. The symbol of Cuicatlan in the Selden Roll 214
97. Glyph of Cuicatlan 215
98. The separation of Cuicatec from Proto-Mixtec 216
99. Genealogy of Cuicatec dynasties . . . . *following* 220

TABLES

1. Sequence of Preceramic Components . . . . *following* 12
2. Radiocarbon Dates from Coxcatlan Cave (Tc 50) 17
3. Radiocarbon Dates from Abejas Cave (Tc 307) 20
4. Radiocarbon Dates from Purron Cave (Tc 272) 23
5. Radiocarbon Dates from San Marcos Cave (Tc 254-1) 23
6. Radiocarbon Dates from the Ajalpan Site (Ts 204) and Burial Pit (Ts 204C) 27
7. Radiocarbon Dates from the Coatepec Site (Ts 368e) 29
8. Radiocarbon Dates from the Las Canoas Site (Ts 367) 30
9. A Chronological Chart of Mesoamerica 33
10. A Partial List of Laboratory Numbers of Dates Rejected 38
11. Types of Large-scale Waterworks in Pre-industrial Agricultural Societies 67
12. Plant Remains from Zones J-A of Purron Cave 93
13. Evaporation and Precipitation in the Tehuacan Valley 128
14. Ecological Potential, Wealth and Population Size of Cuicatec Cacicazgos 198
15. The Class Structure of the Cuicatecs 221

CHRONOLOGY

CHAPTER 1

Chronometric Dating

Frederick Johnson and Richard S. MacNeish

THIS WORK is, in effect, a collaboration. In the organization of the Tehuacan Archaeological-Botanical Project, a subsidiary endeavor, A Radiocarbon Chronology for the Archaeological Sequence in the Tehuacan Valley, was organized by Frederick Johnson and supported separately by the National Science Foundation. The work could not have been done without the support and participation of Richard S. MacNeish. The final major section of this chapter is an inevitable development of the analysis which is inherent in the project. This was inaugurated by MacNeish, who produced the primary data and most of the interpretations. It was Johnson's task to analyze and make final selection of the dates used and to assist in the establishment of the chronology. It is difficult to pinpoint responsibility; however, it must be said that the "chronology project" would not have come to pass had it not been for the inclusive Tehuacan project, and for that we enthusiastically acknowledge MacNeish.

The field work aimed at collecting, recording, and accomplishing basic analysis of the samples for radiocarbon dating was done during three seasons in the valley. For this we wish to acknowledge the invaluable assistance of Dorothy M. Johnson who willingly stood in the broiling sun cleaning and preparing the samples as they came out of the ground and endured a stuffy hotel room where she operated a calculating machine, producing answers to many of our questions.

Computer analysis was first suggested by W.H. Hathaway of the Rockefeller Foundation. His preliminary suggestions were followed by an analysis undertaken by C.E. Eyman of the University of Calgary. We are indebted to Dr. Eyman and, through him, to Keith A. Dixon, and to the University of Calgary Data Centre and Anton Colijn of the Centre for an extensive analysis, which in fact supported MacNeish's original seriation.

There are many others who have made major contributions to this study. Discussions of Mesoamerican chronology with the interested and devoted group of archaeologists who are immersed in problems in the area have contributed much to what we have had to say. We have extracted ideas from these conversations and sometimes even confirmed our disagreements, and so it is unfortunate that it is impractical to attempt acknowledging our appreciation to each individual.

We are concerned with the chronology of cultural materials from Mesoamerica in two closely related ways. First, we have accepted the archaeological sequences from the Tehuacan Valley which have been described in volumes 1-3 of this series and which will receive further documentation in volume 5. These sequences have been derived from the stratigraphy in the sites and by comparison and seriation of the stone artifacts, ceramics, plant remains, and other material from each excavated level of the various sites. Radiocarbon dates on levels identified by such analyses help to establish a chronology localized in the valley. A second stage of analysis, evident also in volumes 2 and 3, is based on comparative data and validates relationships implied by the presence in the levels of types of materials, particularly ceramics, which have originated in foreign regions. In an intermediate process not given prominence here, radiocarbon dates on these related levels have been combined with those from corresponding levels in Tehuacan to form a preliminary radiocarbon chronology for Mesoamerica. Finally, all elements that indicate or measure time are weighed one against the other and become the basis for the final judgments resulting in the chronology presented.

Background of Mesoamerican Chronology

Chronology in Mesoamerican archaeology has been the subject of debate for many years. The primary chronometric method employable in archaeological analysis has been the Maya calendar, correlations of which with the Gregorian calendar have from the beginning been subject to controversy. The uncertainties were compounded as attempts were made to date ruins by means of genealogical reconstructions, occupations by dynastic groups, and by employing native Mexican calendars and various records and traditions to date the founding or dissolution of towns and empires. Major emphasis on the dating of buildings and cities continued until very roughly the decade of the 1920's, when the results of stratigraphic excavation and ceramic descriptions and analysis began to appear. Continued development of these latter kinds of research added vastly to the knowledge of sequences and interregional relationship. However, there was great lack of agreement among the several postulated chronologies, and there was no way to resolve the controversies until some chronometric method could be applied. The most successful method is radiocarbon dating, which, after 1948, commenced to reduce the differences of opinion concerning cultural chronology in Mesoamerica to definable terms.

The preceding remarks refer to studies of the later cultures of Mesoamerica. Largely because of archaeologists' preoccupation with these, the preceramic and early hunting cultures received only passing notice until the late 1930's and especially the 1940's. Along with the rather sudden addition of investigation of early man's occupation of Mesoamerica to the former, almost exclusive concentration on the high cultures of the region, came the realization that the assumption that occupation must have been recent was incorrect. This change in attitude was spurred on by a steadily increasing number of discoveries of sites, the lower levels of which could be dated by geochronological methods. There is still much to be learned about the preceramic occupations of Mesoamerica, but a sketchy outline exists, and a tentative chronology based largely on a few radiocarbon dates is a very useful working hypothesis.

At the present time there exists a body of data which, depending upon the amount of research which has been possible in the several regions, varies in degree of completeness. However, it documents the rise and diffusion of human life in the region over a span of more than 10,000 years. Included in this information is a wealth of material that contributes in various ways to knowledge of chronology. We have made a rather comprehensive attempt to reduce this material to a single chronological system. It is an interesting time to be working with the chronology of Mesoamerica, for ideas are in the process of formulation and basic tenets are beginning to appear. New data tend to modify former ideas in the usual manner, but the area of disagreement is now rather precisely defined. Changes are indeed rapid, for in 1963, when MacNeish commenced compiling the data which became the basis for Figures 2 and 3, some of the interpretations he was forced to make were unique and audacious. During 1968, when the task was finally completed, some of our more venturesome hypotheses had become generally recognized as acceptable estimates. By 1971, the scheduled date for publication, it may well be true that the results of some of our labors will have become commonplace background information. That other ideas will be modified and improved is inevitable.

While we have adapted all kinds of chronological information to our purposes, the fundamental chronometric method upon which we have based our estimates in radiocarbon dating. The development of this method was preceded by a period largely before World War II devoted to the discovery of radiocarbon and recognition of many of its properties. Perhaps the most significant of these for dating purposes was the final recognition of the unexpected length of the half-life. The real beginning of the birth of radiocarbon and tritium as it is recognized today is found in discussions which took place in moments of relaxation in the intensely concentrated war research. The results of the earlier radiocarbon investigations were impractical, useless, and perhaps insignificant at that time, but the discussion of them led to the development of radiocarbon and tritium once the exigencies of the war were abated (Libby 1965:745).

Following the war, radiocarbon research continued under Willard F. Libby's direction in a carefully controlled crescendo of activity utilizing and adding to the inadequate data of the time. He and his associates developed the fundamentals of the method of dating, as well as contributing to and stimulating research in many problems which were geophysical in nature. Now, with expansion of the whole area of the research, "we see that radiocarbon and tritium have become firmly locked into the scientific structure of our time . . ." (*op. cit.*, 751).

The discovery of radiocarbon and the various studies of its characteristics led to the realization that the cosmic-ray production in the atmosphere above about 50,000 feet would result in labeling all living matter by radiocarbon in a carbon cycle which was well mixed in the biosphere, atmosphere, and hydrosphere. Another factor recognized was that the supply of radiocarbon to a living organism would be cut off at the instant of death and that the "decay of radiocarbon normally present would measure the time lapsed since death, half being lost every 5730 years" (Libby 1967: 6). Any account of the development of the basic hypotheses, the laboratory procedures and experiments, testing for validity, and other facets of the research, is a fascinating one of applying scientific method to new and untried ideas. The promising, somewhat crude initial results in 1948 have been followed by twenty years of improvement and expansion in which we have seen the development of some eighty-two currently operating laboratories and the determination of more than 20,000 dates. These dates include measurements which have been of significance in geophysical research and which form a uniquely useful, but far from complete, world-wide chronology for the earth sciences, archaeology, and related fields.

The question of the accuracy of radiocarbon dates, including problems that deal with a situation ineptly named "validity," can be divided into two parts which, while not mutually exclusive, have only fundamental generalizations in common. The first part is concerned with the origin and constancy of production of radiocarbon, geophysical considerations, and the physics and chemistry involved in the reasoning behind the method of measuring the soft radiation residual in a dead organism. The other part of the question, when reduced to lowest terms, is mostly concerned with the characteristics of the sample and the degree of accuracy of its identification with a point in a sequence of events. The latter is of vital importance to archaeology, and there was, originally at least, considerable misunderstanding of the significance of radiocarbon dates because humanists had little comprehension of physicists, their objectives and manner of approach, and vice versa.

The relationship between radiocarbon dates and the true ages of samples has been discussed in a long list of papers exemplified by de Vries (1958); Willis, Tauber, and Münnich (1960); Suess (1961, 1965); Damon (1968); Damon, Long, and Gray (1966); Ralph (1959); Ralph and Stuckenrath (1960); Ralph, Michael, and Gruninger (1965); and Libby (1963, 1967). The salient data has been discussed at length at a Nobel Symposium during August 1969 (Olsson 1970). In brief, de Vries (1958) was the first to notice discrepancies between the known calendar age of wood and radiocarbon dates and he suspected a correlation with climatic changes. It has been pointed out by Stuiver (1961), among others, that dates on wood indicate a correlation between the radiocarbon concentration and sunspot activity. Furthermore, not only are there solar-induced changes of a few percent of radiocarbon in the atmosphere, but such changes are superimposed upon a longer time scale. The nature of the latter is as yet imperfectly understood.

Owing in large measure to dendrochronological analysis of the bristlecone pine (Suess 1965, 1970; Ferguson 1970) and a developing application of varve chronology (Tauber 1970) and certain lake sedimentation rates (Stuiver 1970), correlation of radiocarbon dates and sidereal years can be made with increasing confidence. With archaeological problems in mind, Johnson and Willis (1970) have constructed a smooth correction curve covering the past 7,000 years. Short-term oscillations, such as occurred during the past millennium, in all probability have taken place during the time span of the 1969 curve, but they are small in amplitude compared with the major variations. Corrections during the first 5,000 years are based on the bristlecone pine research and the curve is extended to 7,400 years using the deGeer varve chronology, lake sedimentation rates (Damon 1968; Stuiver 1970), and pollen zonation. However, the basis for such correlations is not yet satisfactory. It is obvious that the corrections must be applied universally for the lengthening out of the time occupied by periods of culture development, especially those dated about 3300 B.C., applied equally to the Neolithic of northwestern Europe and various New World complexes of comparable age.

The Tehuacan sequence is recorded by a series of complexes as previously described. Anticipating the establishment of estimates of the age of these complexes and conversion of these to sidereal time produces the accompanying tabulation.

Complex	*Radiocarbon Years*	*Sidereal Time*
Ajuereado	ends at 6800 B.C.	ends at 7400 B.C.
El Riego	6800 to 5000 B.C.	7400 to 5800 B.C.
Coxcatlan	5000 to 3400 B.C.	5800 to 4150 B.C.
Abejas	3400 to 2300 B.C.	4150 to 2850 B.C.
Purron	2300 to 1500 B.C.	2850 to 1900 B.C.
Ajalpan	1500 to 800 B.C.	1900 to 1000 B.C.
Sta. Maria	800 to 150 B.C.	1000 to 150 B.C.
Palo Blanco	150 B.C. to A.D. 700	150 B.C. to A.D. 780
Venta Salada	A.D. 700 to 1500	A.D. 780 to 1500

The effect of conversion to sidereal time is to make the earlier complexes even older, locating them in the presently more tentative portion of the curve. El Riego commences earlier and is about 200 years shorter than indicated by radiocarbon. This phase or complex — a direct descendent of Ajuereado, which is probably a part of the original and basic primary hunting complex — is difficult to distinguish from the preceding one and the length of the time of existence is presently somewhat uncertain and lacking in real meaning. The next phase, Coxcatlan, is a different story because it appears about 800 years earlier than radiocarbon indicates, continues for 1,650 years and ends about 750 years earlier than radiocarbon estimates. Differences in the length of time are perhaps not significant, but to push back in time the botanical developments, especially the cultivation of maize, has significant implications for the New World as a whole.

The span of 1,300 years in sidereal time of the Abejas phase is 200 years longer than the span provided by radiocarbon. The additional centuries leave more time for the establishment of agriculture and associated developments in the Tehuacan Valley. The Purron phase marks the addition of pottery to the culture of the valley, but we know little else concerning the complex. However, the actual beginning date is older than the radiocarbon estimates. Of greater interest are the dates for the Santa Maria phase, which in sidereal time is 200 years longer than formerly estimated, thus providing more actual time for the development of village life and irrigation.

In the two following phases, Palo Blanco and Venta Salada, we see the rise of true urban communities and city-states supported by full-time specialists and ruled in the end by dynasties. Sidereal time during the life of these phases is not greatly different from radiocarbon estimates; for example, there is a difference of only eighty years in the date of transition from Palo Blanco to Venta Salada. However, in these periods of rapid change even this length of time many become more significant than it appears to be at present.

Because these comments have been restricted to the information from Tehuacan, this is a limited review of the primary result of an aspect of radiocarbon research that has gained considerable momentum since 1958 when de Vries published the results of his original observations. We record these figures as tentative, especially in the range between 7400 and 5000 B.C. We are more confident of the later dates because studies based on tree rings have now been documented to the point where agreement among the results of most investigators is quite striking. There are indications that the older part of the curve will shortly be confirmed and extended by the correlation of tree rings, varve chronology, terrestrial magnetic studies, and additional, only partly explored, systems of determined time.

One can predict that chronologies will eventually be expressed in sidereal time. Until various methods of determining age can be reconciled with sidereal time, it will be necessary to utilize the primary results. It is certain that radiocarbon dates will be a primary source of chronological estimates for many years to come. Continual effort must be made by physicists in the laboratory and archaeologists in the field to assure the accuracy of the whole operation. Accurate values of radiocarbon dates depend upon the correct determination of the half-life of Carbon-14. The usual constant 5568±30 years first used by Libby has been corrected to 5730±40 years (Mann, Marlow, and Hughes 1961; Olsson and Karlén 1963; Olsson *et al.* 1962). Therefore dates calculated using the older value can be made slightly more accurate by increasing them by 2.9 percent. The difference is negligible and unimportant to archaeologists at the present time. Once conversion to sidereal years commences in earnest, the new half-life will assume greater significance. The present situation is one reason why radiocarbon conferences in 1962 and 1965 confirmed the opinion that the Libby half-life of 5568±30 years should continue to be used in calculating radiocarbon dates.

Since 1948, when Libby announced that radiocarbon dating was possible, there has been a debate concerning the cause and significance of discrepancies between the radiocarbon chronology and archaeological chronological inferences. The latter are based on the evidence of stratification and seriation of artifacts which may either be excavated from a series of levels in sites or picked up in the course of systematic survey, the latter being a valid manner of sampling. After some twenty years during which some 20,000 dates have been scrutinized and evaluated by scholars in numerous scientific fields, there is a general agreement among scientists, including archaeologists, that radiocarbon dates have provided a valid chronological framework upon which to hang the fabric of prehistoric culture development and distribution. The conflicts between the testimony of radiocarbon dates on samples and archaeological inferences, when they are not due to rare mistakes or identifiable laboratory problems, originate almost without exception in the sample. When one considers the number of possibilities for internal modification of samples subsequent to deposition, which are often difficult or impossible to identify, the degree of success in dating which has been achieved is remarkable. It is even more so in view of the fact that it is sometimes impossible for an archaeologist to determine with the degree of precision necessary the specific origin and association of a sample. During the history of the determination of dates, anomalous arrangements of combinations of dates and archaeological sequential data have appeared. As time went on, addition of newly excavated and dated samples germane to such problems have resulted either in the solution or in progress toward solution. From inspection of the record over the years one can only conclude that final judgment concerning serious discrepancies between radiocarbon dates and archaeological opinion must be held in abeyance until additional or more suitable data become available.

One principle which has been very difficult for archaeologists to apply when using radiocarbon dates it that the determination was made on the sample and that the date is that of the sample. Whether or not the sample dates a specific level depends to some degree upon its composition and to a very large degree upon the observation and judgment of the person who collected it. There are well-known possibilities of contamination by admixture of older or younger foreign carbon. Shells, for example, may incorporate older carbon from lacustrine deposits and comparable sources. Keeling (1961) has shown that samples may be affected by the local radiocarbon environment; for instance, bacterial decomposition of organic components of soils. There is also the possibility of the ingestion of carbonates by growing organisms which can lead to small differences between the date determined and the true radiocarbon age. These differences are really negligible, and in any case, many of them can be avoided by careful observation and adequate description.

Another facet of the problem of accuracy and validity is the purely archaeological one. Just how valid is the archaeologist's statement that a sample "dates level D," or that "platform IV of building C is dated" by a specific sample? We will consider this problem in various ways in reference to Mesoamerican dates as the discussion proceeds. Only rarely is it possible to check the location of a sample once it has been sent to the laboratory to be dated. A date on an outwardly satisfactory sample that does not conform to established dates for a sequence or well-founded ideas of a chronology in which it should fit poses a real problem.

The detailed record of the recovery of the sample must be subject to review. This includes not only the detailed but the general situation which is responsible for opinion concerning sequence and chronology. There is also a subjective difference between accuracy and usefulness. Testing will show that there are few dates in any sequence which are not valid in the range of three sigma. In fact, on the basis of the archaeological record, one can assume that dates outside this range of error are probably contaminated or their provenience has been improperly identified. It is true, however, that the range of error of three sigma and usually the range of two sigma, except when this is very small, impairs the usefulness of the date in establishing the chronological position of archaeological events.

In the following analysis we have made a rather strict interpretation of the dates. In a number of cases we have not been satisfied with the archaeological record, and dates said to have specific provenience have been discarded whether or not they appear to support the chronology we are proposing. These are dangerous and difficult decisions to make, for we are passing judgment on the validity of a record of field work, and our competence to do this may be questioned. For practical reasons we have resisted statistical testimony and chosen to consider only the one sigma range of the dates selected. The results of this decision can be seen in the charts and tables where dates valid in the range of two or more sigma have been "rejected" as not being useful for present purposes. The degree of success justifies this rather stringent criterion. We have examined in detail more than 400 records of dates from the entire Mesoamerican region. Of these we accept 218 as being useful in the range of one sigma. Aside from the value of the chronology it appears as testimony supporting the radiocarbon method. Certainly a properly determined radiocarbon date on a sample of known provenience is an estimate having a well-defined degree of accuracy.

Building the Tehuacan Chronology

The objective here is to provide a chronology for cultural development in the Tehuacan Valley. As in other analogous areas no single complete and detailed measure of time is available, making it necessary to reconstruct the chronology through the use of stratigraphic information and other data having temporal significance. Among the latter, seriation of artifacts based on typology and analysis of the vertical and horizontal distribution of wild and domesticated plant remains are of primary importance. Interpretations derived from these data are presented against a background of a chronology based on radiocarbon dates. A large portion of this combined information is in the form of inference or estimate, but the quantity and variety of it and its consistency comprise a body of estimates that have a narrow range of error so presenting a uniquely useful and dependable hypothesis.

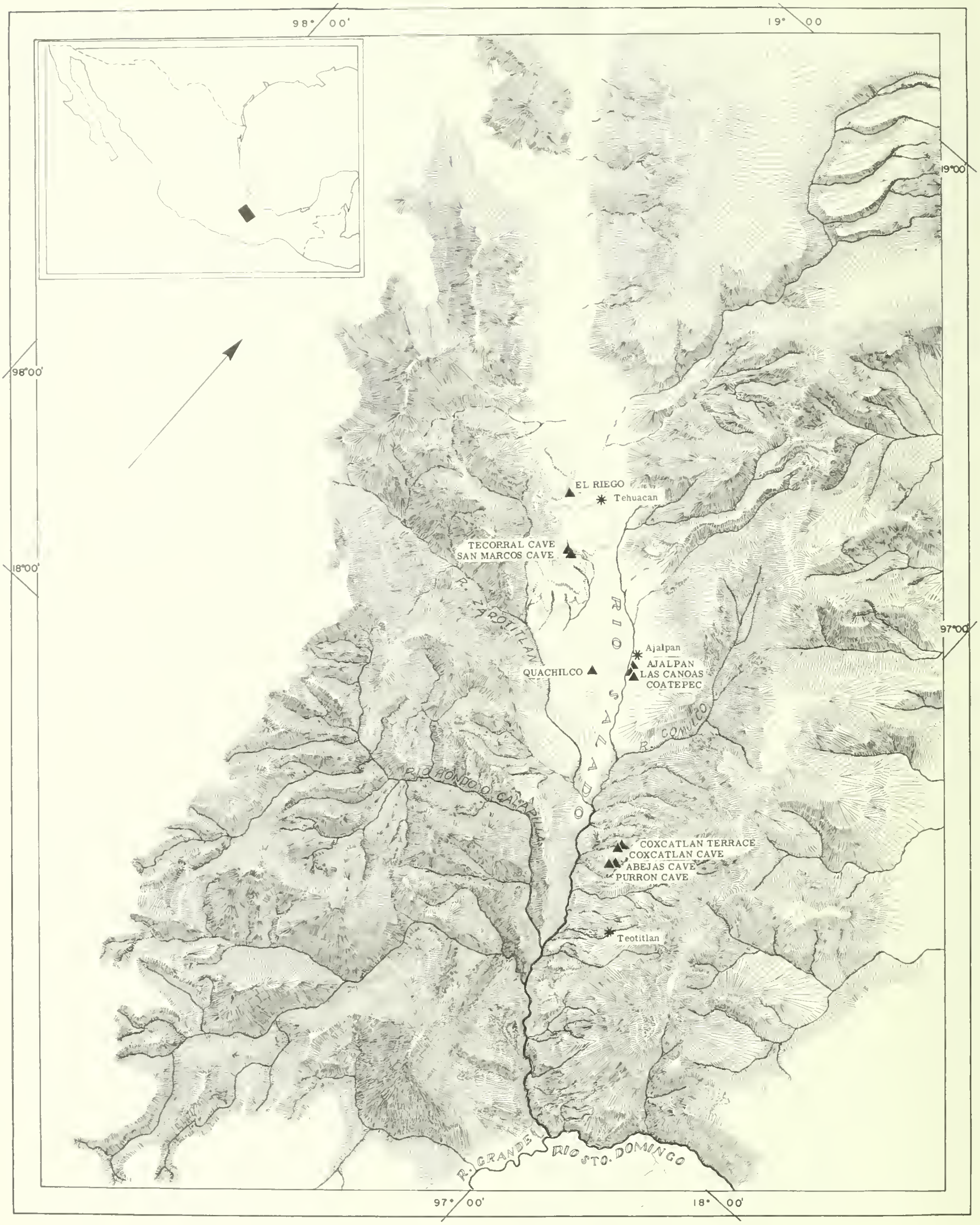


Fig. 1. The Tehuacan Valley, showing major stratified sites.

We have found that some radiocarbon dates from sites in the Tehuacan Valley, when they were not obvious physical or archaeological mistakes, were out of line either with opinions concerning archaeological order or with the series of dates based upon this order. There are no discernible reasons for such discrepancies. Presently there is no other recourse than to reject these seemingly anomalous dates. We are, however, acutely aware of the dangers involved in this occasionally very arbitrary selection. We have included a record of the rejected dates from the Tehuacan series in Table 10, for new data may prove that some of our judgments have been clouded by the human propensity to choose the easiest solution.

The basis for the Tehuacan chronology is the excavation of stratified sites combined with the results of the archaeological survey of the valley. An objective of the excavations was to bring to light the stratigraphic sequence of cultural data which would in turn contribute to the understanding of the origin and development of civilizations. A complete sequence was not found at any one site, but the comparison of content of levels at some sixteen excavated sites revealed overlapping suites of zones or levels of occupation and established a complete sequence of archaeological components in the valley. Information of geochronological import from the biological and earth sciences and also geographic data complimented and expanded the basis for the sequence and, it follows, for the chronological inferences. The chronology of the zones in sixteen of the sites is diagrammed in Fig. 3.

Two kinds of sites were investigated in detail. Cave or rock-shelter sites were important particularly for the older materials and because organic materials, both rubbish and artifacts, were preserved in most of the zones, The principal cave sites are Coxcatlan (Tc 50), Purron (Tc 272), the East and West Niches of El Riego (Tc 35e and 35w), Tecorral (Tc 255), Abejas (Tc 307), and San Marcos (Tc 254). Also included is the Coxcatlan Terrace site (Ts 51) at the base of the talus coming from Coxcatlan Cave and located on a terrace of the arroyo which the cave faced.

The second variety of sites were the open sites in the central part of the valley near the town of Ajalpan. In this region clay pits occupy a huge area which has been filled with various alluvial deposits. An underlying layer of clay was covered with five to ten meters of a combination of the layered refuse of human occupation and water-laid silts, sands, and fine gravels. The clay is suitable for making tile, but in order to secure it miners had to remove the overlying refuse and alluvial deposits. Centuries of such mining has left desolate badlands in which mesas, buttes, and irregularly-shaped peninsulas are the remnants of the overlying deposits. By inspecting the walls of these remnants, archaeologists were able to choose sites suitable for stratigraphic excavation and analysis.

The open sites are known as Ajalpan (Ts 204, Ts 204D, etc.), Coatepec (Ts 368e and 368w), Las Canoas (Ts 367), and Quachilco (Tr 218). The Quachilco site located a few kilometers west of the clay pits is an extensive ruin consisting of rectangular mounds located on the south and east sides of a large plaza, which itself is surrounded by an artificial rectangular embankment.

Excavation of both the cave and open sites followed the archaeological method of digging alternate squares and working from a vertical face. Cross sections on intersecting north-south and east-west walls were recorded to provide a meticulous control and record of the excavations. Each stratigraphic layer or zone was considered to be a deposit laid down during a limited interval of time. Usually each zone was relatively uniform in color and content, often differing from deposits above and below, regardless of whether it was ash, debris of occupation, rocks fallen from cave roofs, water-laid or wind-deposited sand, clay, silt, or other materials. Each zone was usually capped by a well-marked stratum or by an interruption of the soil after the nature of a disconformity. These discontinuities were of various kinds: for example, a charcoal floor, a layer of vegetable material, or a floor comprised of dirt or other material which had become consolidated, presumably by trampling. In every case the discontinuity marked the end of a period of deposition of either human refuse or natural soil.

In our excavations, in many instances we segregated the artifacts from the top of a zone from those found in lower parts of the zone. By doing this we could trace changes in the quantity and types of the artifacts during the period represented by the zone and from zone to zone. This often resulted in a designation such as "B^1" to distinguish the floor capping the zone from the general depositional refuse accumulated during the earlier time of the deposition of Zone B. As is to be expected, the established system was subject to exception by specialized situations or the requirements of the person in charge of excavation.

The sequential alignment of the zones from the excavated sites and the components discovered during the surface survey has been established by the stratigraphy at the excavated sites combined with the seriation of artifacts. This latter method has been adapted by MacNeish from the method developed by the late James

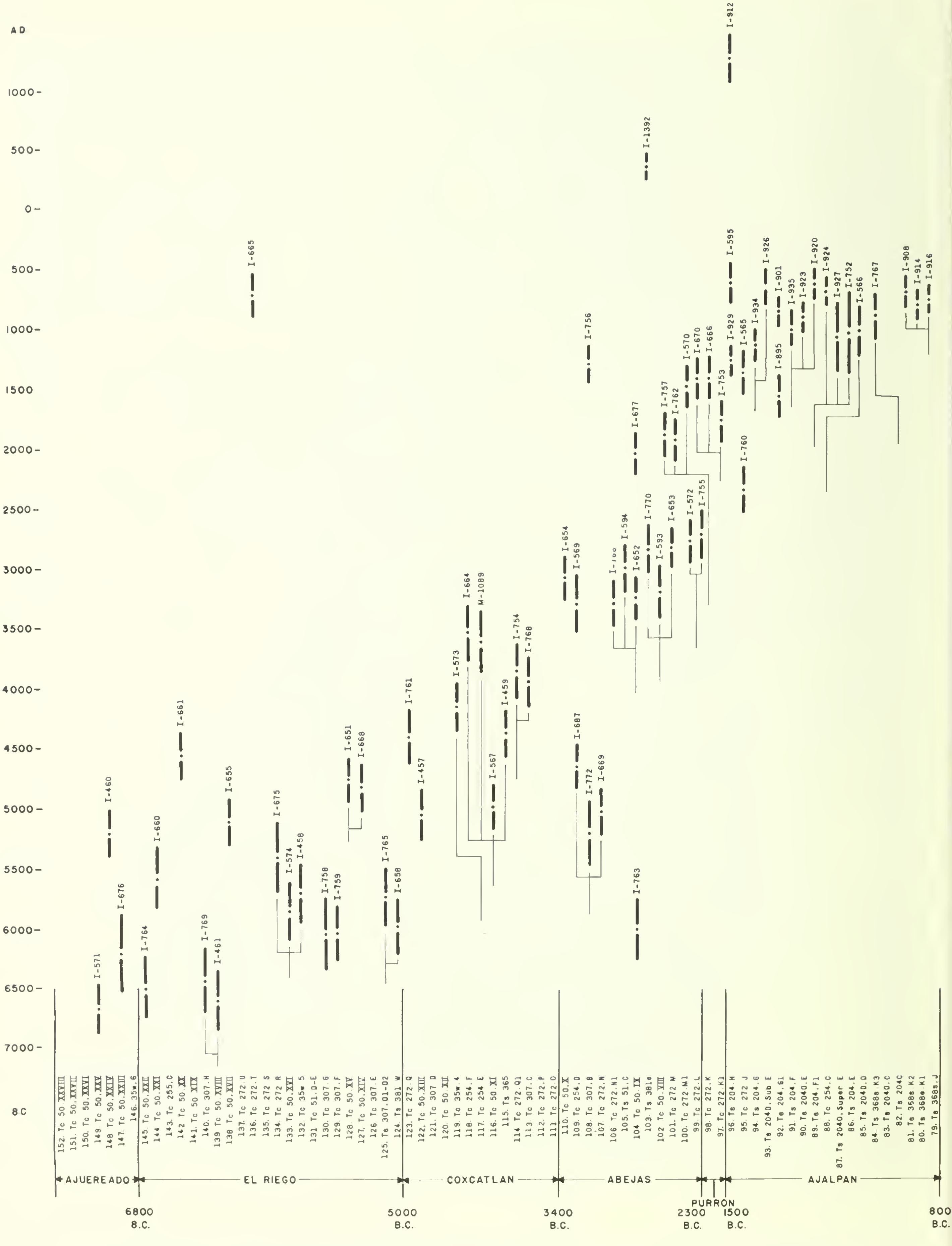
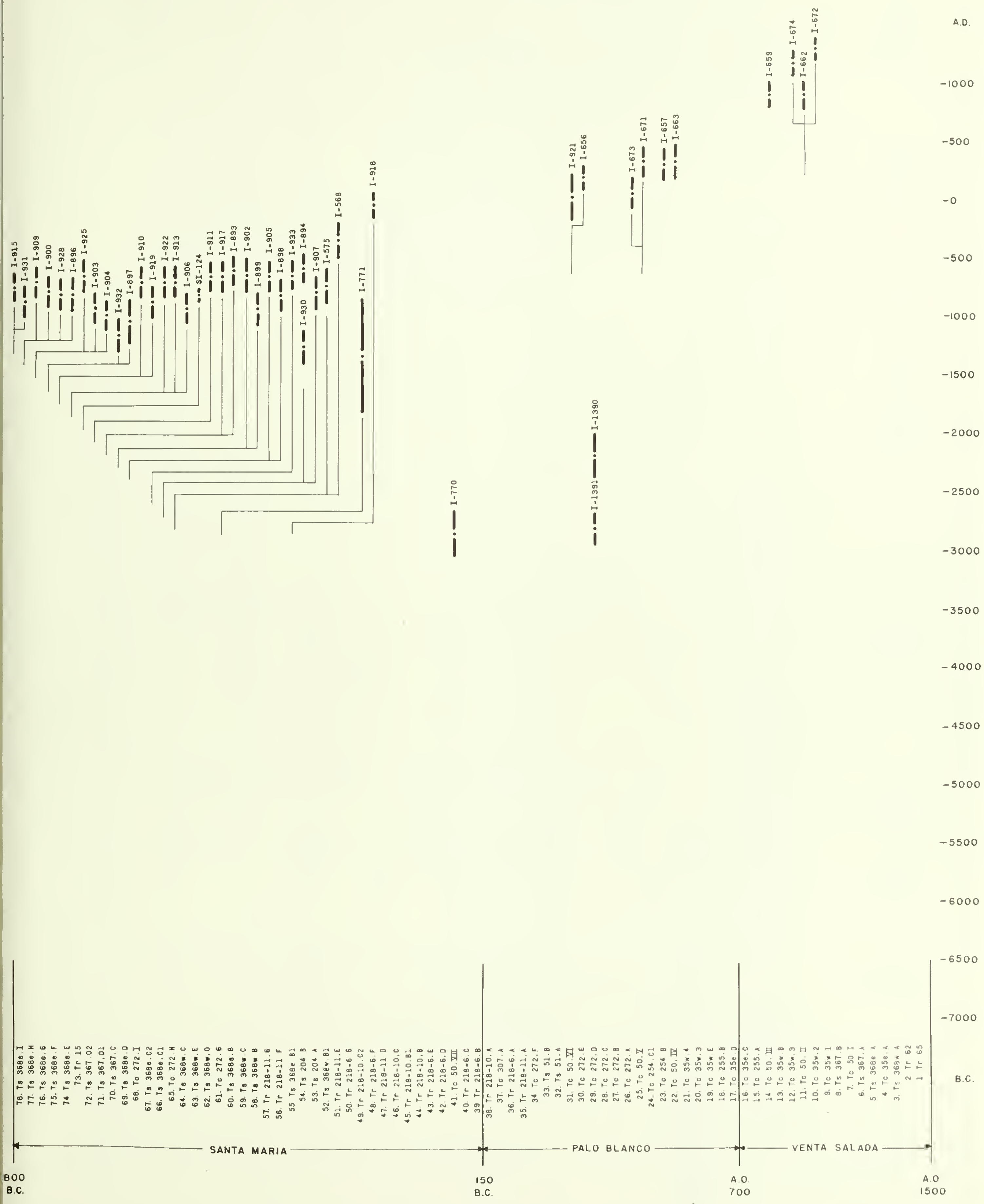


Fig. 2. Radiocarbon dates on zones in the Tehuacan Valley. (One sigma range of error is indicated by bar-dot line.)


I-915
I-931
I-909
I-900
I-928
I-896
I-925
I-903
I-904
I-932
I-897
I-910
I-919
I-922
I-913
I-906
SI-124
I-911
I-917
I-893
I-902
I-899
I-905
I-898
I-933
I-930
I-894
I-907
I-575
I-568
I-771
I-918
I-770
I-921
I-656
I-1390
I-1391
I-673
I-671
I-657
I-663
I-659
I-674
I-662
I-672
A.D.
-1000
-500
-0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
-5500
-6000
-6500
-7000
B.C.
78. Ts 368s.I
77. Ts 368e.H
76. Ts 368e.6
75. Ts 368e.F
74 Ts 368s.E
73. Tr 15
72. Ts 367.02
71. Ts 367.D1
70. Ts 367.C
69. Ts 368e.D
68. Tc 272.I
67. Ts 368e.C2
66. Ts 368e.C1
65. Tc 272.H
64. Ts 368w.C
63. Ts 368w.E
62. Ts 368w.0
61. Tc 272.6
60. Ts 368s.8
59. Ts 368w.C
58. Ts 368w B
57. Tr 218-11.6
56. Tr 218-11 F
55 Ts 368e B1
54. Ts 204 B
53. Ts 204 A
52. Ts 368w.B1
51. Tr 218-11.E
50. Tr 218-6 6
49. Tr 218-10.C2
48. Tr 218-6.F
47. Tr 218-11 D
46. Tr 218-10.C
45. Tr 218-10.B1
44. Tr 218-10.B
43. Tr 218-6.E
42. Tr 218-6.D
41. Tc 50.VII
40. Tr 218-6.C
39 Tr 218-6.B
38. Tr 218-10.A
37. Tc 307.A
36. Tr 218-6.A
35. Tr 218-11.A
34 Tc 272.F
33. Ts 51.B
32. Ts 51.A
31. Tc 50.VI
30. Tc 272.E
29. Tc 272.D
28. Tc 272.C
27. Tc 272.B
26. Tc 272.A
25. Tc 50.V
24. Tc 254.C1
23. Tc 254 B
22. Tc 50.IV
21. Tc 35w.4
20. Tc 35w.3
19. Tc 35w.E
18. Tc 255.B
17. Tc 35e.D
16. Tc 35e.C
15. Tc 255.A
14 Tc 50.III
13. Tc 35w.B
12. Tc 35w.3
11. Tc 50.II
10. Tc 35w.2
9. Tc 35w 1
8. Ts 367.B
7. Tc 50 I
6. Ts 367.A
5 Ts 368e A
4 Tc 35e.A
3. Ts 368w A
2 Tr 62
1 Tr 65
SANTA MARIA
PALO BLANCO
VENTA SALADA
800 B.C.
150 B.C.
A.D. 700
A.D 1500

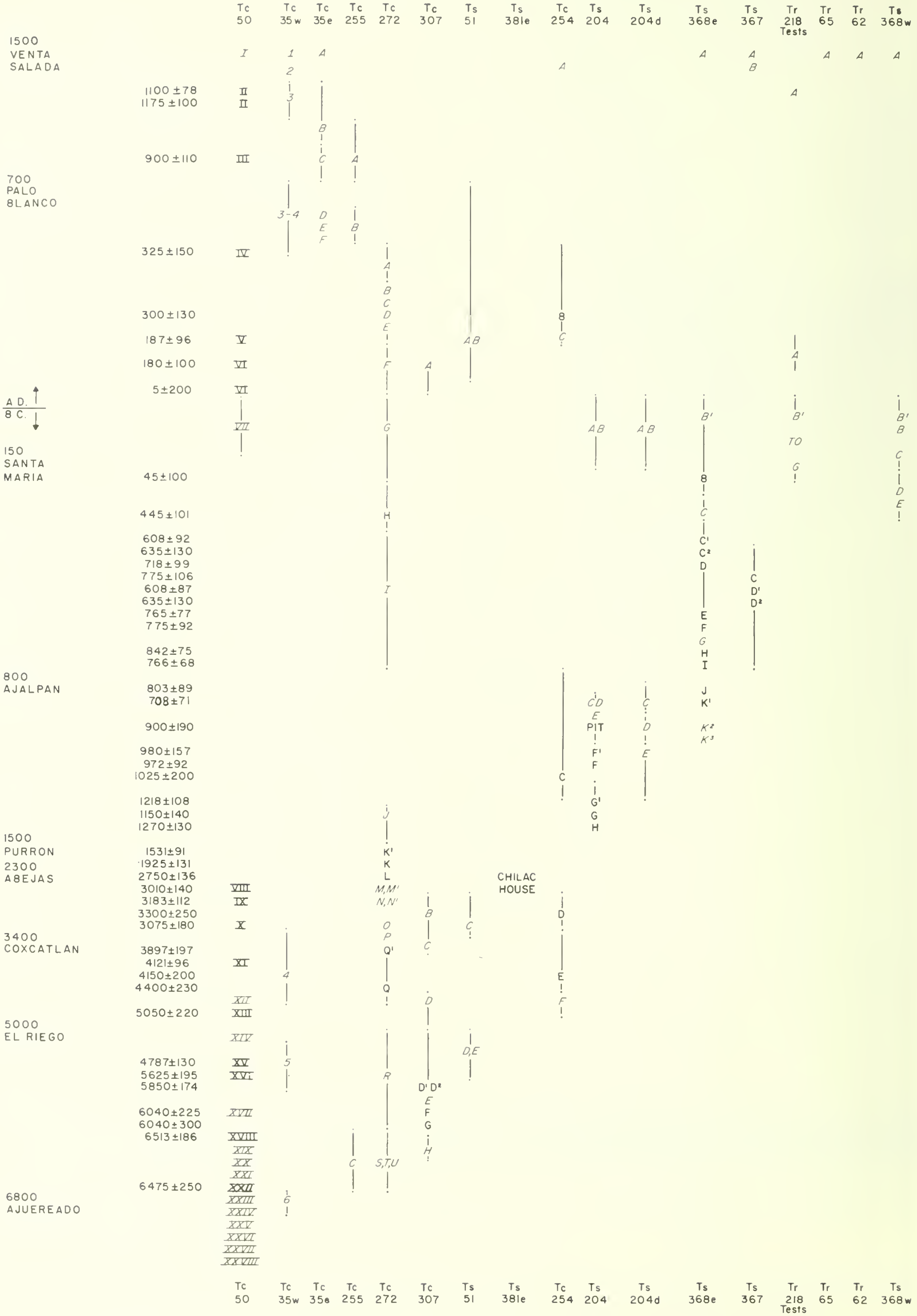


Fig. 3. Chronology of zones in stratified sites. (Dated zones are indicated in boldface roman type.)

TABLE 1

Sequence of Preceramic Components

(Based on 79 sensitive artifact types from 52 excavated levels.)

	TOTAL ARTIFACTS	Flake gravers	Crude keeled end-scrapers	Spokeshave-like tools	Crude blade fragments	Crude blades, unprepared platforms	Nicholas burins	Crude ovoid end-scrapers	Slab choppers	Flake choppers	Lerma points	Crude flat-flake end-scrapers	Scraper-plane fragments	Blocky-core choppers	Abasolo points	Plainview points	Muller fragments	Cylindrical pestles	Tecomate mortars	Crude blades, prepared platforms	El Riego points	Mortar fragments	Boulder metate-milling stones	Multifaceted scraper-planes	Domed scraper-planes	Flat-topped scraper-planes	Gouges	Ellipsoidal choppers	Spherical battered pebbles	Flacco points	Ovoid mullers	Discoidal choppers	Thin-flake end-scrapers	Ovoid bifaces	Crude blades, pointed platforms	Nogales points	Biface fragments	Flaring-rim mortars	Hemispherical mortars	Crude discoidal end-scrapers	Tortugas points	Trinidad points	Hidalgo points	La Mina points	Conical pestles	Long rectangular pestles	Agate Basin points	Stone bowl fragments	San Nicolas points	Square-based bifaces	Boulder trough metates	Abejas points	Tilapa points	Ovoid manos	Coxcatlan points	Oblong manos	Anvil stones	Tecomate bowls	Shumla points	Pebble choppers	End-of-blade scrapers	Almagre points	Garyito points	Large bifacial disks	Fine blade fragments	Catan points	Hemispherical bowls	Pelona points	Spherical manos	Fine blades, unprepared platforms	Fine rectangular blades	Long manos, lenticular cross section	Cuboid pestles	Small bifacial disks	Polishing pebbles	Flaring-rim stone bowls	Spherical beads	Paint palettes	Rubbed pebbles	Ovoid plano-convex metates
ABEJAS																																																																																	
Tc 272, L	8													2			1						3																																																								1	1	
Tc 272, M^{1}	0																																																																															
Tc 272, M	0																																																																															
Tc 50, VIII	131	2		3	1	6			1	2		4	1	1	2		6			3		1	5			1	4	1				6	4	1	12		8			9		1							2	1	1		2	2	6	2	1			2	2	3	6		1	1		7	2					1	1		1	1	1	
Ts 381e	38				1									2										1	1			4				1		4	2					1								2	1		1	1		1		4		2	1	1			1				1	1		1		1				1		1		
Tc 50, IX	286		3	5	16	13		2	1	6		6	3	4	6		7			4			1		1		3	3	3		5	12	5	3	29	1	16			13		2	2					1	4	2		1	4	5	41	1			1	7	1	6	20	2	1			6	2	1	1	1		1	1					1
Ts 51, C	27								1	1		2	3							1			1		2		4					1					1			3									1						1	2					1			1								1											
Tc 272, N^{1}	2																																																															1	1															
Tc 272, N	20									5				4			1										1			1								2																										1					2	1									1	1						
Tc 307, B	53	4		2	1			4				6					10						4				3			1	4	2	1							3									1	1														1		1	1	1							1		1						
Tc 254, D	21				1								2	1	1			1			1						1	2	2							2								1																								1			1	2						1				1							
Tc 50, X	280	1		6	16	5			3	11		4	4	2	3		6			4			6		1	2	3	1	1	1	8	6	4	1	27	3	13			13		5		1			2		9	2	1		6	3	58	1	1			6	1	6	5	6	2	2	1	4			1	1			1					
COXCATLAN																																																																																	
Tc 307, C	13					1		1									2						4		1							1	1																																					1						1										
Tc 272, O	2							1																																				1																																							
Tc 272, P	5												1			1							1						1																																								1										
Tc 272, Q^{1}	0																																																																															
Ts 365, test	7								1																																															1				1			1							1	1			1											
Tc 50, XI	308	6		6	13	15		1	4	10		13	7	1	4		13			6			14		2	3	10	4			5	15	3	4	20	4	14			17		8	1				2		6	4	1		23	8	18	6		1		4		5	4	1				1	1											
Tc 254, E	8				1														1						1	1						1		1							1																																	1													
Tc 35w, 4	142	3		4	3	4		1		2		10	7	3	1	1	7			3	1	2			1	4	6	3		1		9	5	2	6	1	7		3	5		4		1			1		4	1		1	8		8				1	3		1	1		1	2													
Tc 50, XII	123	4		1	9	8				3		2	5	1	1		8			4		4	4		2	1	4			1	2	7	2	2	7		6		1	8		1							1	3			6	2	5	1			1	1	1	2	1	1															
Tc 307, D	12				1							1		1			2										1					1			1			1																	1	1		1																										
Tc 272, Q	7																1						3	1		1																													1																										
Tc 50, XIII	111	5	1	4	7	6		1		5		2	1	3	1		5			2		1	4		3	2	4	5		2	3	6		1	1	1	5			9				1			1				1	1	3	3	5	1	2	1		2																			
EL RIEGO																																																																																	
Ts 381w, pit	27				2				1		1			2	3							1	1	3	2	3						1		2	1																2		1		1																												
Tc 307, D^{1}D^{2}	28					1		1		1		2	3	1			1			1			4	2		3		2			2		1	1			1			1																																							
Tc 307, E	26		1	2		5				2			1	2					5								1						2	4		1																																										
Tc 50, XIV	296	5	3	15	17	12		5	4	10		11	20	15	1		5	2		10		4	6	7	12	17	12	7		2	8	9	10	4	6	1	8		2	16	3	14		1	2	1	3	1					4												1																	
Tc 50, XV	311	8	5	18	3	11		2	3	9		16	22	10	2		23	1	1	25		6	5	9	22	14	8	7	1	3	4	8	9	1	7		9		1	18	1	7	1		2	1	2		1				3	1	1																								
Tc 307, F	17				1	1	1						1			1		4			1					2	1	1	1			1																					1																								
Tc 307, G	42		1	2	2						3					2					5	8	1	2	2	1	2	1		1						4	1				1			1							1	1																												
Ts 51, DE	210	8	2	13	5	9		6		6	1	9	17	9	5		3	1		10		5	2	12	12	11	5	9				1	3	4	1		17	2	1	3		5	2	5	1		2		1	1				1																									
Tc 35w, 5	107	2	2	6	4	1		1		3	1	13	10	6	2		6			2	1	3	1	7	5	5	5	1			1		5	1			4		1	1		1	2	1			2	1																														
Tc 50, XVI	301	3	7	4	6	15		4	6	17	5	28	20	16	1	1	9	1		26	3	2	8	15	20	11	9	7	3	3	4	10	1	4	4	1	6		2	10	1	3	1	1		2		1																													
Tc 272, R	80											1					29					1	34	1	1						12										1																																						
Tc 272, S	14									1			1				2							9							1																																																
Tc 272, T	2																							2																																																							
Tc 272, U	2																							2																																																							
Tc 50, XVII	101	1	1	5		1		2	1	5		8	10	8	1						3		5	1	5	13	8	1	7	1	3	1		1	2				1		3			1		1	1																																		
Tc 50, XVIII	229	3	7	7	5	12	1	7	6	9	4	18	23	17	3	1	5	2	1	8	1	4	5	3	12	19	11	6	1	3		3	7	2	3		2			5	2	1																																						
Tc 307, H	12		1	1		1							1				1					1			1							1			2		1	1																																										
Tc 50, XIX	64		2	1		6		6		3	2	5	6	8		1	4			3	1		1		1	4	1			1		2		2				1	2	1																																								
Tc 50, XX	40		2	2	2	4		4	1	1	1	2	3	1							1		1	2			2	3	1				1	2		1	1	2																																											
Tc 255, C	38				2	2			1				7	2	8							4				1	3	1	2	1	1				2	1																																															
Tc 50, XXI	25	1	1	1		1		1	1	2		2	2		1		1		1	2	1				1	1				2	1	2																																																
Tc 50, XXII	23	1	1						1		1		2	3	1						1	2	2	1	1	1	2	1	1	1																																																				
AJUEREADO																																																																																	
Tc 35w, 6	18		2	1	1	2	1	1		1	1	2	1	2	1	1			1																																																													
Tc 50, XXIII	55	1	9	1	1	6		4	3	3	4	12	5	2	1		1	1								1																																																						
Tc 50, XXIV	26	3	8	2		2		2	1	1	1	3	1	2																																																																
Tc 50, XXV	7		1	1	2	1	1			1																																																																			
Tc 50, XXVI	2		1		1																																																																								
Tc 50, XXVII	2		1		1																																																																								

Ford (1962). These methods as they apply to the present studies have been described in chapter 2 of volume 1, the Introduction and Conclusion to volume 2, and chapter 1 of volume 3 and need not be repeated here. The resulting alignment of over 150 excavated zones in the valley has been tested and, as far as possible, confirmed by the statistical analyses of Dr. Charles E. Eyman. Practical considerations have made it necessary, especially in the tables in previous volumes, to place the zones in linear lists which, taken literally, imply that each zone is younger than the one preceding it and which also give the misleading impression that all zones are of equal duration. This linear arrangement is not the true one, for the occupation zones lasted for varying lengths of time and their spans often parallel or overlap each other in time. The occupation of some zones in some sites may well have lasted as long as the occupation of several zones distributed both horizontally and vertically among several sites. To establish a chronology that provides the exact timing of these details has proven to be nearly impossible, if one desires to produce a sequence of terminal dates susceptible to proof or at least having a degree of accuracy stronger than poorly controlled guessing. We speak from experience, for a table setting forth such estimates was constructed at the time when the radiocarbon dates were first tabulated. In the end, however, the validity of these estimates became so hypothetical owing to the lack of necessary supporting details that the table was discarded.

The situation is not actually as bad as it sounds because the nearly impossible task of determining the exact chronological position of single zones is offset by the relative ease with which groups of zones that are closely related culturally can be assembled into sequent phases and subphases whose chronology can be established within acceptable limits of accuracy. All this data is broadly summarized in Fig. 3. Inferences concerning the order of zones within the phases and the times when they were occupied are supported in part by correlative dates and sequences from neighboring regions as set forth below (see Fig. 4).

There have been various descriptions and discussions in the preceding volumes identifying the eight "breaks" in the cultural sequence delimiting the nine cultural phases to which the content of the sequent zones can be assigned. The phases document the evolution of culture in the Tehuacan Valley, beginning with the early hunting cultures, continuing through the development of agriculture, and culminating in the rise of urban civilizations. Of most interest here is the observation that these phases are also units having chronological implications.

Before applying the dates to the sequence a note must be made concerning the statistics employed in an attempt to improve the accuracy of the seriation. C.E. Eyman of the University of Calgary constructed the computer analysis of the Tehuacan data and incorporated the results in the first draft of a lengthy report which included a mass of tables and explanatory data. This has not been reproduced. Essentially the work tested the seriation done by MacNeish, and, with insignificant exceptions, this seriation survived the statistical test. Johnson has had the temerity to modify the alignments of zones proposed by MacNeish and Eyman by the imposition of a very strict interpretation of the radiocarbon chronology. There are sections in the chronological alignment where the MacNeish and Eyman alignment can easily be incorporated within the three sigma error of a radiocarbon date, indicating general agreement of the systems. However, we have restricted the use of dates largely to the one sigma range of error, and this has occasionally modified the statistical results in a manner that appears to border on a cynical ignoring of the data. It is not as bad as that. There is an attempt, patently subjective, to provide an alignment and chronology which has limits useful to the rather stringent needs of archaeological reconstruction of culture development.

Computer seriation of the lithic, maize, and ceramic materials was accomplished by utilizing an IBM 360/50 disc-drive computer at the Data Centre of the University of Calgary. The program employed was adapted from version two of a FORTRAN IV language program developed by Kuzara, Mead, and Dixon (1966). Their matrix-ordering technique seems to be a closer approximation to the model described by G.W. Brainerd (1951) than the seriation program devised by Marcia and Robert Ascher (1963), because the Kuzara, Mead, and Dixon program allows for randomization of the initial order of the matrix imput.

The analysis considered first the nonceramic artifact types as they occurred in almost all excavated components. As indicated in volume 2, not all classes of nonceramic artifacts were sensitive temporal indicators, and such types were not considered. Moreover, all components did not have adequate samples of sensitive artifact types, and some components could be aligned chronologically much better than others. In sum, the variable character of the data, including the fact that each zone only occasionally produced truly representative results, made it impossible to secure positive results in spite of many hours of devoted labor on Eyman's part. We re-emphasize that this is not the fault of the matrix-ordering method but of the available data which were not amenable to such analysis. The results have not been entirely rejected, for where the data permit, they have been used to support situations needing clarification.

Approximately 200 carefully located samples to be used in establishing a radiocarbon chronology for the prehistory of the Tehuacan Valley were collected from sixty-two zones in nine excavated sites. From this collection 111 samples were selected for dating. Duplicate runs on some samples to check or confirm the dates resulted in the determination of 121 dates by Isotopes, Inc. of Westwood, New Jersey. One additional date each was determined by the laboratories at the University of Michigan and at the Smithsonian Institution, making a grand total of 123 dates. The dates, with commentary and description, are published in *Radiocarbon* 4:200, 7:250, and 11:89-102.

The longest series of dates was determined on samples from Coxcatlan Cave because that site is the major source of knowledge concerning the stratigraphy of the valley. In selecting samples for dating it was necessary to rely upon first impressions which gave rise to snap judgments concerning the meaning of the field data and preliminary classifications of cultural materials usually while excavation was in progress. Certainly, if it had been possible to wait until analyses were completed, samples from additional zones would have been selected and processed. This special problem of sampling for dating purposes is of course common to all archaeological work, for samples can only be collected during excavation and at the moment when a sufficient quantity of the right kind of material is discovered under circumstances permitting meticulous record. It is impossible to anticipate fully what needs will be revealed by final analyses of both the dates and the archaeological material. The exception to this is the rare opportunity to return to sites not completely excavated for the express purpose of collecting samples. This was possible in three sites in the valley. Despite certain lacunae in the suite of Tehuacan dates, the chronology is reasonably comprehensive. Duplicate samples from zones were collected whenever possible. Preliminary analysis of the field data revealed that some zones were especially significant, and so dates on several samples found within such zones, sometimes as many as four, were determined in order to establish the age as firmly as possible.

Another factor influencing the selection of samples was the opinion that the older zones were deposited over relatively long spans of time with consequent lack of precision in ages of the upper and lower boundaries so that fewer dates were needed to establish an estimate of the ages of the more ancient zones. On the other hand, the younger zones, especially from Formative and later times, recorded either more rapid cultural change or they lasted for shorter lengths of time. In order to establish the chronology of this more rapid development, it was necessary to determine dates on a greater number of more closely spaced samples.

Samples for the Tehuacan series came from two main types of locations. Those from the cave sites were taken, for the most part, from formerly occupied floors. The state of preservation determined whether the sample was wood, vegetable material, or charcoal found on the floor itself or in hearths on the floors. Some hearths were located in pits, and because of uncertainties of original provenience and association, owing to possible mixture of material by aboriginal excavation, samples from such locations were not collected except under unusual circumstances. With a few exceptions, charcoal and wood samples were made up of small pieces, which, hopefully, originated in fagots. This kind of selection was intended to avoid problems of "post-sample growth" (Coe and Stuckenrath 1964). Furthermore, the charcoal selected was as homogeneous as conditions permitted to enhance the possibility that the average death rate of the wood which was carbonized might be close to the actual one. A radiocarbon date on such samples, within the limits of the standard deviation, can be a very close estimate of the actual one. Such a date probably is a good approximation of a very short interval during which a given floor was in use. It does not indicate the entire span of time during which the floor may have been occupied. It is of course desirable to provide dates for the beginning and ending of the life of a zone. This is impractical if not impossible to do because there is only a remote possibility that an adequate supply of satisfactorily preserved material would ever be found in the required specific localities. We are forced to use single, or less often multiple, dates from samples in a zone as the basis for estimates of the period during which the zone was occupied. The situation in caves is of course the most favorable because a series of dated floors from a succession of zones provide a good basis for estimating the lengths of the intervals between them. Such estimates can be used to locate the boundaries of the zones in the chronology.

A word should be said about the terminology employed here. It is impractical to qualify a date every time it is mentioned and so we use expressions such as "the date of a zone," or "Zone XV is dated 4787±134 B.C." Such expressions are used with the full knowledge and understanding that the single date is only one point in the period of time a zone was occupied, and we quote the date as a symbol of the time span of that period. In some instances other kinds of information permit estimating whether earlier or later phases of zones may be indicated by a date.

At open sites the kind of sample selection used in the caves was not feasible because preservation of organic material was poor and excavation was difficult in the dry, hard, clayey soil. The charcoal appeared as small fragments scattered through the deposits. Fireplaces were rarely identified by quantities of charcoal and though boundaries between zones were distinguishable, actual packed down, occupied floors were rarely seen. Diffidently, one assumes that the very small bits of charcoal are the result of the erosion of twigs and that post-sample growth is not an important factor. The major question is the spread of the death dates of the fragments comprising a sample. The unavoidable circumstances of the excavation and collection is reason for the opinion that death dates may vary over the length of time required for the development of the arbitrary level being excavated, or more likely, the whole zone. The dates from such sites therefore are more generalized estimates of the ages of zones than are dates from the floors in the caves. The difference in the source of samples affects the interpretation of the whole range of dates presented in the graphs and tables.

Every attempt was made to reduce the chances of intrusion of noncontemporaneous materials into samples. This was not always easy, but the degree of success is more than satisfactory as may be seen by inspection of Fig. 2. The samples from the caves are probably more satisfactory than are those from the open sites. It was often possible for the archaeologist in charge of cave excavation to collect and record the location of the samples himself. The area from which the sample came was limited and the position of it in the deposit coul be easily determined.

In the open sites, on the other hand, the charcoal was usually scattered in small bits through the deposit. It was picked up and placed in aluminum-foil envelopes by the workmen as they excavated, often with small trench picks. The person in charge trained the workmen, most of whom were very cooperative; he also kept watch on the excavation and collection as well as conditions permitted. Envelopes of samples were collected from the workmen as soon as the samples were large enough to permit date determination in the laboratory. As they came out of the trenches, the samples included a great deal of soil, some roots, and other materials which were not useful for dating purposes. The process of concentrating the charcoal was done in various ways. Excavations carried on by Dorothy and Frederick Johnson were designed especially for the purpose of collecting samples at these sites and it was possible to clean the samples and seal them in sterilized jars immediately upon collection. In other excavations samples were collected in aluminum foil to be cleaned and sealed either in the laboratory in Tehuacan or at the R. S. Peabody Foundation in Andover.

A system of numbering samples was devised and the record of collection made on a form printed for the purpose. This record was also included in the field notes. The dating laboratory, Isotopes Inc., was sent the numbered samples from which it was possible to identify only the sites from which they came. This was not a purposeful precaution, except in case of duplicate samples, but in effect the simple system made it impossible for the laboratory men to make valid estimates of the relationship of one sample to another because the samples were numbered at random as they came out of the excavations.

The laboratory analysis was routine and has been described by Walton, Trautman, and Friend (1961). The dates were calculated using the value 5568±30 years as the half-life of carbon—14. If the new value for the half-life, 5730 ± 40, is preferred, the present dates may be corrected by multiplying by 1.03. This is not deemed necessary or desirable in the present discussion. In 1962 all radiocarbon research people accepted A.D. 1950 as the standard year of reference for all dates whether B.P. or in the A.D./B.C. system (Godwin 1962). This agreement was confirmed in 1965 (Johnson 1965).

The dates selected to use in building the Tehuacan chronology are not entirely satisfactory from the archaeological point of view, especially if only the one sigma range of error is considered. There are, for example, groups of dates from specific zones which have a greater range than can be accommodated by the archaeological data. There are, also, dates suggesting an order which does not correspond in detail with the stratigraphy in a given site. The zones from all sites have been arranged in an order by seriation of the artifacts they contain and are presented in Fig. 3. This represents archaeological opinion, utilizing biological and other data and based upon definition of types of artifacts and plants and their temporal and spacial distribution. In combining the dates with the seriated order, difficulties arise. Frequently, especially in Formative and later times, problems arise from the fact that the time during which a number of zones develop is relatively short, and it is likely also that some zones in different sites overlap each other. In such instances the method of radiocarbon dating is not sufficiently sensitive to distinguish the age of one zone from another.

The Ajuereado Phase

The Ajuereado phase is the earliest so far known in the Tehuacan Valley; its major characteristics have been described in volumes 1 and 2. Ajuereado is best known from Tc 50, Zones XXVIII to XXIII, the lowest zones uncovered during the excavation of Coxcatlan Cave. This site is of major importance to the understanding of the cultural sequence in the valley because its twenty-eight zones, with some lapse in continuity of occupation, spanned the development of culture in the valley from proto-historic and historic times to the beginning of human existence there as we know of it today.

The excavation of the floor of the cave, which measured about thirty meters parallel to the opening and some four to ten meters from the talus to the back wall, proceeded in a conventional manner, commencing with trenches based on test pits and expanding along the lines of the grid coordinates initially established. Excavation was accomplished by stripping off zones from vertical faces in alternate squares, permitting meticulous control from intersecting east-west and north-south cross sections.

The physical stratigraphy of the cave is divided into three major divisions, the lowest of which, including Zones XXVIII to XXV, was found in the northwestern sector of the cave. Zone XXVIII, lying on the natural floor of the cave, was composed of disintegrated rock and fine sand in which there were a few animal bones but no artifacts or stone chips. The zone was not capped by a floor of any identifiable kind. The assemblage of bones, some of which represent animals now extinct in the valley, suggests the possibility that they may have been collected by human beings and deposited there during the accumulation of this basic stratum. There is nothing other than this by no means conclusive evidence to suggest that Zone XXVIII was occupied by man.

Zones XXVII, XXVI, and XXV contained a few artifacts (Table 1), and a succession of small floors made up either of combined humic material and finely comminuted charcoal or vegetable matter clearly indicate human occupation. This occupation has been called early Ajuereado, but the scarcity of artifacts permits only hypothetical reconstruction of the culture. A radiocarbon date on early Ajuereado Zone XXV (Table 2, no. 37) is not satisfactory as will be explained below.

Zone XXIV marks the beginning of the second division of the physical stratigraphy in the cave. This zone was difficult to identify for it was included in the loose rock of the bottom of the cave. Through careful excavation stone artifacts could be associated with the zone, for they probably did lie in situ, but fine-grained non-contemporaneous carbonaceous materials may have filtered down through crevices in the rock fill. In the western sector of the cave Zone XXIV was overlain by a succession of zones, XXIII to XIX. These zones did not extend far to the east, and in the latter area Zone XXIV was capped by Zone XVIII, which actually covered the entire surface of the cave including the area of Zone XIX. However, the cultural materials did not follow this distribution precisely, for the late Ajuereado subphase was identified only in Zones XXIV and XXIII.

In looking for resemblances of artifact types in excavated components at other sites we find that only the assemblage from Zone 6 of the West Niche of El Riego Cave (Tc 35w) was at all similar. This well-defined ash zone lay directly on the cave floor. It averaged only 5-6 cm. thick, with a maximum thickness under 20 cm., and covered about 13 square meters. This limited occupation held eleven diagnostic traits in common with Zone XXIII and additional types found in Zone 6 added to the inventory of Late Ajuereado such types as Nicholas burins, tecomate mortars, and Plainview projectile points (Table 1), foreshadowing the increase in popularity of the latter two types in later occupations. The radiocarbon date from Tc 50, Zone XXIII, has been rejected (Table 2, no. 35).

Zone XXII included ten traits not found in underlying zones nor in Tc 35w, Zone 6. Also there are four traits in Zone 6 which were not present in Zone XXIV, and so one concludes that occupation of Zone 6 ended with the late Ajuereado occupation in El Riego Cave which occurred during or at the time of the end of the life of Zone XXIII.

Fig. 2 and Table 2 show the distribution of the dates from the Ajuereado phase in Coxcatlan Cave and Fig. 3 correlates the zones in various sites. The cultural material from the Ajuereado phase, sparse though it is, is older in parts of Mexico and the New World than is implied by the dates determined at this site. There may be a reason for this. In Coxcatlan Cave, below Zone XVIII, the boundaries between zones were sometimes difficult to identify and were interrupted by rock falls from the roof. It is easily possible that the finely broken up organic debris filtered down through the deposit made porous by crevices between the rocks, and sometimes this filtering could have happened during excavation. These observations can well account for the anomalous distribution of the dates. They do not apply to

TABLE 2
Radiocarbon Dates from Coxcatlan Cave (Tc 50)

Date No.		Location	Date	Date or Average Date Selected
Venta Salada Phase				
(1)*	I-672	S2E11-II (level 2)	A.D. 1300 ± 100	A.D. 1100 ± 78
(2)	I-662	S2E11-II (level 2)	A.D. 900 ± 120	
(3)	I-674	S2E11-II (level 3)	A.D. 1175 ± 100	A.D. 1175 ± 100
(4)	I-659	S2E11-III (level 4)	A.D. 900 ± 110	A.D. 900 ± 110
Palo Blanco Phase				
(5)	I-663	S2E11-IV	A.D. 325 ± 150	A.D. 325 ± 150
(6)	I-671	S2E11-V	A.D. 325 ± 120	A.D. 187 ± 96
(7)	I-673	S2E11-V	A.D. 50 ± 150	
(8)	I-656	S1E15-VI	A.D. 180 ± 100	A.D. 180 ± 100
(9)	I-921	Burial 1-VI	A.D. 5 ± 200	A.D. 5 ± 200
Santa Maria Phase				
(10)	I-770	Pit 43-VII	2850 ± 200 B.C.	Rejected
Abejas Phase				
(11)	I-653	S1E15-VIII	2820 ± 175 B.C.	3010 ± 140 B.C.
(12)	I-593	S2E10-VIII	3200 ± 200 B.C.	
(13)	I-677	S2E10-IX	2050 ± 180 B.C.	Rejected
(14)	I-763	W7-IX	6000 ± 250 B.C.	Rejected
(15)	I-594	S2E10-IX	3000 ± 200 B.C.	3183 ± 112 B.C.
(16)	I-652	S2E11-IX	3250 ± 180 B.C.	
(17)	I-766	S2E10-IX	3300 ± 200 B.C.	
(18)	I-654	S2E11-X	3075 ± 180 B.C.	3075 ± 180 B.C.
Coxcatlan Phase				
(19)	I-567	W4-XI	4975 ± 200 B.C.	4121 ± 96 B.C.
(20)	I-664	S2E8-XI	3525 ± 230 B.C.	
(21)	M-1089	S1W6-XI	3610 ± 250 B.C.	
(22)	I-459	S2W4-XI	4375 ± 200 B.C.	
(23)	I-457	S2W4-XIII	5050 ± 200 B.C.	5050 ± 220 B.C.
El Riego Phase				
(24)	I-651	S1E12-XV	4750 ± 180 B.C.	4787 ± 134 B.C.
(25)	I-668	S1E12-XV	4825 ± 200 B.C.	
(26)	I-458	S2W4-XVI	5750 ± 250 B.C.	Rejected
(27)	I-675	S1E10-XVI	5400 ± 300 B.C.	5625 ± 195 B.C.
(28)	I-574	W6-XVI	5850 ± 250 B.C.	
(29)	I-655	S2E13-XVII	5100 ± 190 B.C.	Rejected
(30)	I-461	S2W4-XVIII	6600 ± 250 B.C.	6513 ± 186 B.C.
(31)	I-769	S1E8-XVIII	6425 ± 275 B.C.	
(32)	I-661	S1E11-XX	4550 ± 200 B.C.	Rejected
(33)	I-660	S1E11-XXI	5570 ± 250 B.C.	Rejected
(34)	I-764	S1E14-XXII	6475 ± 250 B.C.	6475 ± 250 B.C.
Ajuereado Phase				
(35)	I-676	S2W4-XXIII	6200 ± 340 B.C.	Rejected
(36)	I-460	S2W4-XXIV	5200 ± 200 B.C.	Rejected
(37)	I-571	N1E3-XXV	6675 ± 220 B.C.	Rejected

*Numbers in parentheses are for text reference.

the stone artifacts which were too large to move very far in this way. A general trend from early to late can be seen in the distribution of the dates (Fig. 2). However, after a great deal of experimentation and searching the record, we have come to the conclusion that it is impossible to validate one date from Ajuereado zones and reject others. The archaeological material and the conclusions derived from comparisons with other sites in Mexico are, in our opinion, more convincing than the dates on samples from Zones XXV, XXIV, and XXIII.

The artifacts and the extinct animals in these levels are comparable to those which in neighboring parts of Mexico date from 7000 to 13,000 B.C. and even earlier. We assume that the similarities in content indicate that these early deposits in the Tehuacan Valley must have been coeval, or at least of an analogous antiquity, with those in neighboring parts of Mexico. Division of Ajuereado into two subphases, "early" and "late," is based on a very small but at the same time definitive amount of data. The age of Zone XXVIII can be estimated to be older than 10,000 B.C. on the basis of the extinct fauna and some evidence of changes in climate (Flannery 1967); unfortunately there were no artifacts. Zones XXVII to XXV may represent early Ajuereado and are estimated to be older than 7600 B.C. The remaining Zones XXIV and XXIII, with the latter's correlative Zone 6 in the West Niche of El Riego Cave, we hypothesize were in existence before 6800 B.C., the estimated date for the beginning of the El Riego phase.

The El Riego Phase

Types of artifacts defining the El Riego phase were found in Coxcatlan Cave (Tc 50), the West Niche of El Riego Cave (Tc 35w), Tecorral Cave (Tc 255), Purron Cave (Tc 272), and Abejas Cave (Tc 307), in the Coxcatlan Terrace (Ts 51), and in the open site near Chilac (Ts 381w). A suggested alignment of zones in these sites and a chronological order based on combined cultural and chronological information is diagramed in Fig. 3. The new artifact types in Tc 50, Zone XXIII, and Tc 35w, Zone 6 (Table 1), indicating an evolution of late Ajuereado out of the early part of the phase, presage a change in the cultural content shortly to give rise to the El Riego phase. Ten additional traits found in Zone XXII differentiate it from XXIII and establish the El Riego phase in Coxcatlan Cave. The phase boundary in Tc 35w between Zone 6 and overlying Zone 5 can be located with even more certainty, because Zone 5 has a relatively large inventory of "sensitive" types which include artifacts of later varieties than any found in Zone 6, as will be noted in more detail below.

Artifact types of the early El Riego subphase in Coxcatlan Cave were found in Zones XXII and XIX in the west portion; in Zone XVIII, which was a very clearly marked zone covering the whole surface of the cave; and in Zone XVII, which overlay Zone XVIII and covered a small sector of the west end of the cave. Early El Riego materials were also found in Tecorral Cave (Tc 255), where the stratigraphy was extremely simple. Zone C, resting on the natural floor of the cave, was comprised of yellow soil and rock fall mixed with small patches of ash. The zone produced enough artifacts to permit classifying it as early El Riego (Table 1), and the artifact assemblage suggests that it existed about the time of Tc 50, Zones XXI and XXII. The presence of extinct turtle and antelope bones, however, indicates either that occupation of Zone C may have commenced earlier than suggested above or that the older materials, including the tools, had become mixed in the deposit. Since there are more blades with prepared than with unprepared striking platforms among the tools, Zone C may be as late as Zone XVIII of Coxcatlan Cave.

Early El Riego artifacts were found in the lower levels of Purron Cave, a relatively small rock shelter located in the wall of a small canyon tributary to the Arroyo Lencho Diego. The rather complete excavation of about seven meters of refuse revealed only a small number of artifacts, but the stratigraphy was very clear. Zone U, the lowest, was found in a small test pit in the bottom of the cave below Zone T. Zones T, S, and R were layers of soil combined with rock from the roof and in places covered sizeable areas. No floor was identified in Zone U, but layers of ash, sometimes including burned earth, covered Zones T and S. Zone R was capped with a layer of charcoal, which, in the south, was interrupted by a large roasting pit.

The very limited sample of artifact types from Tc 272, Zones U, T, and S, when compared with Coxcatlan Cave, places them in the range of zones later than Zone XXII. They may have been in existence during a period including the beginning of El Riego and ending with Zone XVIII. Zone R did produce a Trinidad point. Such projectile points are not found in Coxcatlan Cave before Zone XVIII. When this fact is combined with the waning popularity, or even disappearance, of multifaceted scraper planes, mullers, milling stones, and domed scrapers, we assume that Zone R could have continued into the late El Riego subphase, after the time of Zone XVIII at Coxcatlan.

Comparable El Riego types were found in Zones F, G, and H of Abejas Cave, which was located near Purron Cave. The excavations revealed a basic layer of rock resulting from a combination of scale from the roof and erosion of the natural floor. The zones were comprised of mixed refuse, patches of ash and charcoal, and areas of rock fall; they varied somewhat in their horizontal dimensions. Zones H, G, and F included no definite floors.

The sparse artifacts from Zone H, a shallow pit-like deposit, suggest an early El Riego period; occupation may have begun about the time of Zone XX at Coxcatlan, perhaps to last until about the time of Zone XVIII. Zones G and F produced more specimens and examples of additional types, though still in quantities too small to justify much more than an estimate of their period. Computer analysis indicated that these two zones were occupied during a time range measured by the end of Tc 50, Zone XVIII, and extending through the span of Zone XVII or perhaps into the time of Zone XVI. The latter extension, however, is prevented by a radiocarbon date (Table 3, nos. 5, 6) that places the time of Zones D^1 and D^2 of Abejas Cave between Zones XVIII and XVI and this confines Zones G and F to about the time of Zone XVII.

Tc 307, Zone E, was a layer of light brown soil covering Zone F, except in the north and west where it extended beyond the limits of Zone F to cover basic natural layers. Zone D^2 was composed of reddish brown soil and some refuse lying on Zone E. Zone D^1 was platey rock from the roof separating the lower occupation from the dark brown soils of Zone D, the upper floor. The sample of artifacts from these zones was very limited, but they appear to be the remains of late El Riego occupations roughly contemporaneous with Tc 50, Zones XVII and XVI — or, as the computer would have it, Zones XVIII to XIV inclusive. Radiocarbon dates indicate that the zones may be correlated more closely with Zone XVII. Materials from Zone D include later artifact types, so it is classified with the succeeding Coxcatlan phase. Apparently there was a hiatus in the occupation of Abejas Cave between Zones D^1 and D. Probably this interruption of occupation was due to an extensive collapse of the roof of the cave resulting in a sterile level.

The late El Riego subphase in Coxcatlan Cave is represented by Zones XVII through XIV. These zones were composed of soils and refuse in which there were floors and charcoal layers. Together with the relatively larger number of artifacts, these layers were evidence of concentrated and lengthy occupation.

The Coxcatlan Terrace site (Ts 51) was located on a lower terrace of the arroyo in front of Coxcatlan Cave. The cultural materials were found in levels lying on top of water-laid sand and gravel. Zone E was composed of heavily burned soil including cultural debris and was capped by a thin charcoal layer called Zone D. Artifacts from these zones are classifiable as late El Riego, for they are quite similar to those from Zone XVI of Coxcatlan Cave. However, San Nicolas points, Agate Basin points, and an ovoid mano suggest that the zone may have been occupied during a span of time terminating with Zone XV at Coxcatlan Cave. Zone 5 of the West Niche of El Riego is very similar in content to Zone D-E of Coxcatlan Terrace, except that San Nicolas and Agate Basin points and an ovoid mano suggest that occupation of Zone 5 at El Riego may have commenced a little earlier than Zone D-E at Coxcatlan Terrace; that is, during the time of Zone XVI at Coxcatlan Cave.

A date on a sample from floor 3 of Tc 50, Zone XXII, 6475 ± 250 B.C. (Table 2, no. 34), has been accepted as a general indication of the age of this zone. This is the lowest zone in Coxcatlan Cave which is classified as El Riego, but it does not date the beginning of the phase. As noted above, we believe that the El Riego occupation commenced about 6800 B.C.

Zone XVIII produced two samples suitable for radiocarbon dating, one each from square S1E8 and S2W4. These samples are separated horizontally by four or five meters, but even so the dates determined are rather closely comparable. The average, 6513 ± 186 B.C. (Table 2, nos. 30, 31) is perhaps the firmest early date in the series from this cave. The samples are described as charcoal and vegetable material collected from fine sand. A reason for having some confidence in this date is that Zone XVIII was a rather clearly marked stratum which covered the whole floor of the cave without serious interruption, and there is great probability that the organic material collected was homogeneous. The zone also produced a large number of artifacts, 229 of which were classified into 37 "sensitive types" (Table 1), indicating antiquity and also rendering the zone as one with an easily identifiable and specific character.

There is no date on a sample from Tc 50, Zone XVII. Zones G and F of Abejas Cave have an artifact content which can be placed anywhere in the Coxcatlan sequence between Zones XVIII and XVI inclusive as noted above. The dates of Tc 307, Zone G, 6040±300 B.C., and Zone F, 6040 ± 225 B.C. (Table 3, nos. 7, 8) locate them in a rather narrow span of the sequence represented by Tc 50, Zone XVII, the limits being established by dates on Zone XVIII and the dated Abejas Zones D^1 and D^2, which are near the transition between Tc 50, Zones XVII and XVI (Fig. 3). The data indicates that late El Riego commences with the beginning of Zone XVII or about 6000 B.C.

Two closely spaced dates indicate the age of Zone XVI at Coxcatlan Cave as 5625 ± 195 B.C. (Table 2, nos. 27, 28). The problem with a third date, however, is

TABLE 3
Radiocarbon Dates from Abejas Cave (Tc 307)

	Date No.	Location	Date	Date or Average date Selected
		Abejas Phase		
(1)*	I-756	S3E3-B (level 2)	1310 ± 150 B.C.	Rejected
(2)	I-772	N1E1-B (level 2)	5210 ± 275 B.C.	Rejected
(3)	I-669	S2E2-B¹	5025 ± 190 B.C.	Rejected
(4)	I-667	S4E3-B¹	4650 ± 190 B.C.	Rejected
		El Riego Phase		
(5)	I-765	S4E3-D¹	5725 ± 250 B.C.	5850 ± 174 B.C.
(6)	I-658	S2E3-D²	5975 ± 250 B.C.	
(7)	I-759	S1E2-F	6040 ± 225 B.C.	6040 ± 225 B.C.
(8)	I-758	S4E3-G	6040 ± 300 B.C.	6040 ± 300 B.C.

*Numbers in parentheses are for text reference.

the record. I-458, 5750 ± 250 B.C. (Table 2, no. 26), was determined on a sample which came from Square S2W4 in an area where it was discovered, upon analysis of the field notes, that "Zone XV was very thin and so the sample may have originated in the lower zone [XVI] or it may be a combination of charcoal from the two zones." The date has been rejected despite the fact that it is compatible with other dates from Zone XVI. One of the two valid dates, I-675, 5400 ± 300 B.C., was determined on wood which, when collected, was packed in a sterile bottle having an improvised top. Presumably it came through to Andover from Mexico uncontaminated; the date is close enough to the other valid date, I-574, to be averaged with it. There was a question concerning the provenience of the sample I-574, but this has been resolved and the date of 5850 ± 250 B.C. is considered valid. The average of the two dates, 5625 ± 195 B.C. for Zone XVI appears to be of the right order in the cave.

Zones D¹ and D² of Abejas Cave have an average date of 5850 ± 174 B.C. (Table 3, nos. 5, 6). As in the case of Zones F and G, the number of artifacts and the seriation of them results in a wide range of possibilities. However the date falls between those for Zone XVII and lower Zone XVI (Fig. 3). This compression of the time for the occupation of Zones G, F, D², and D¹ in Abejas Cave leaves a gap between Zone D¹ and the following Zone D. This is easily acceptable because D¹ was covered with a heavy fall of rock.

The average date 4787 ± 134 B.C. for Zone XV of Coxcatlan Cave (Table 2, nos. 24, 25) appears to be slightly out of order if 5050 ± 220 B.C. for Zone XIII (Table 2, no. 23) is correct. The two dates imply that Zones XV, XIV, and XIII were not occupied for as long a period as the preceding zones. In other words, the total span of time of Zones XV, XIV, and XIII was of shorter duration than the overlapping span of Zones XVI and XV. However, the difference between these two is really unimportant and the date 5000 B.C. for the end of the El Riego phase is a useful estimate.

The Coxcatlan Phase

The generation of the Coxcatlan phase out of El Riego is marked by changes in subsistence patterns and an increasing inventory of domesticated plants. The hunting practices of the people of the earlier phases were gradually being replaced by the collecting of wild vegetable foods and the cultivation of such plants as corn, beans, squash, and chili peppers. There may have been some experimentation with the cultivation of fruits. The stone industry produced such new types as Coxcatlan, Garyito, Shumla, and Almagre points and oblong manos, stone bowls, pebble choppers, and other artifacts.

Zones including Coxcatlan phase materials were excavated from Coxcatlan, the West Niche of El Riego, Purron, Abejas, and San Marcos (Tc 254) caves. At Coxcatlan Cave Zone XIII was some 30 cm. thick. The dark-colored refuse at the bottom merged toward the top with a combination of plant remains, bones, and stone artifacts and chips, all of which indicate concentrated human activity. Zone XII was a thin dark layer of limited extent. Zone XI covered the entire surface of the cave. It varied in thickness from 40 cm. to about 10 cm. and in some sections was capped by a layer of preserved vegetal remains. This zone was prominent and clearly identifiable in all sections, and the numerous artifacts and definitive assortment of plant remains render it a primary source for the definition and classification of the Coxcatlan phase (Table 1).

Zone 4 of the West Niche of El Riego had an adequate sample of artifacts which were very similar to those from Zones XII, XI, and X at Coxcatlan Cave, suggesting contemporaneity, possibly with Zone XI. The artifacts from Tc 35w, Zone 4 — and also those from the transition (3-4) to Zone 3 — show some similarity to artifacts from Zone 5 and a continuity is indicated. This continuity is contradicted by the inferences based on radiocarbon dates which show that Zone 5 is some 600 years younger than Zone 4 (Fig. 3). Despite the similarities there are significant differences in the artifact inventories of Zones 4 and 5, including many new projectile point types and square-based bifaces and stone bowls in Zone 5 (Table 1).

In Purron Cave, Zone Q was a layer mainly of yellow silt and sand covered in its southern portion by a rock fall. Zone Q[1] was a layer of soil capped with ash overlying the rock fall and Zone Q in sections north of it. Zones P and O were layers of soil, some of which contained large proportions of ash, and Zone O actually was capped with ash. The stratigraphy was quite clear, but chronological relationships are another problem. There were only fourteen identifiable stone artifacts in three of the zones, and Zone Q[1] included only a burial. The typology of the artifacts is reason for a tenuous suggestion that Zone Q is later than Tc 50, Zone XV, and Zone P, because of a spherical mano, can be linked to Zone XI. These suggestions are modified slightly by the radiocarbon dates as noted below.

The sequence in Abejas Cave is a little difficult to evaluate because of the relatively small number of sensitive artifact types. Zone C overlay Zone D in the east and a large area of rock fall which was resting on Zone D[1]. There is no radiocarbon date for either Zone D or C, and lacking further information, we assume that there was a break in the continuity of occupation between Zones D and C, perhaps as a result of the rock fall. Zone D with its Coxcatlan, Abejas, and Tilapa points appears to be appreciably earlier than Zone C, and it is certainly later than Zone XIV in Coxcatlan Cave. We have therefore indicated in Fig. 3 that Zone D may be placed in a range between the times of Tc 50, Zones XIV through XII. We add that it surely did not exist for any great length of time. Zone C, on the other hand, can be assigned to the early Abejas subphase or a transitional Coxcatlan-Abejas span of time. Some small support is given this latter assumption by the presence of fine-blade fragments (Table 1) suggesting that Zone C was later than Tc 50, Zone XI.

Zones F and E of San Marcos Cave were classified as Coxcatlan phase largely because remains of wild maize were found in them, suggesting that the levels could be as old as Zone XIII at Coxcatlan Cave. Limitations on the age and range of the levels are posed by the artifacts and radiocarbon dates. Eight artifacts from Zone E, including hemispherical stone bowl fragments, indicated that the zone must be later than Zone XIV at Coxcatlan Cave. A radiocarbon date 4150 ± 200 B.C. (Table 5, no. 4) places the zone at about the time of late Zone XII or early Zone XI (Fig. 3). These zones were identified in small areas in the cave. Zone F was a small charcoal layer and Zone E was made up of thin flakes of rock capped by a zone of charcoal and preserved plant remains.

Establishment of the date for the beginning of the Coxcatlan phase at about 5000 B.C. is based largely upon the radiocarbon date for Zone XIII of Coxcatlan Cave. This date on Zone XIII, recorded as 5050 ± 200 B.C. (Table 2, no. 23), is the best evidence we have because the data from the artifact seriation are weak. Over 100 artifacts from Zone XIII have been classified as sensitive types. However, the dating of three older zones and two younger ones from other sites, is based on a range of seven to twenty-eight artifacts (Table 1). A trend in new types is to be seen with the advent of Zone XIII, but it would have been more convincing if a larger quantity of artifacts had been found in the five levels in question.

The next date in the series is 4400 ± 230 B.C. from Zone Q, Purron Cave (Table 4, no. 18). This would be a significant date in the chronology if the content of the zone, which includes only seven sensitive artifact types, permitted classification of it as something more authoritative than a "possible component." The date of Zone E of San Marcos Cave, 4150±200 B.C., placing it near the time of Tc 50, Zones XII and XI, has been discussed above.

The date on Tc 50, Zone XI, which is the major component in this phase, is an important time marker. It is the average of four dates (Table 2, nos. 19-22), the means of which are spread over 1,450 years. M-1089 was collected in the spring of 1960, I-459 in December 1961, and I-567 and I-664 in February and May 1962. The 1962 samples show the greatest variation. The 1960 sample, M-1089, is very close to I-664, even though determined by a different laboratory, and I-459 is in the middle of the four. The records show that samples M-1089, I-664, and I-459 were from floor 14 of Squares

S2E8, S1W6, and S2W4; I-567 was recorded simply as from the top of the zone in Square W4. There was a problem in identification, for during the course of the excavation the present Zone XI was designated as either I, J, or K. During the field season previous to the completion of the excavations, MacNeish and Fowler, after very careful analysis of the field notes, renumbered all the zones of Coxcatlan Cave in a single system. The location of the present samples fell in Zone XI. There is some suggestion in the dates that the western sections of the cave are older than the eastern ones. This is seen not only in Zone XI but in several other zones. However, this suggestion is not supported by the distribution of the artifacts or by other data from the field notes. As far as can be discovered, there is no archaeological reason for the wide range in the means of the dates.

A study of Fig. 2, especially the relation of the dates from Coxcatlan Cave to the dates from Purron and San Marcos caves, leads one to suspect I-567. Three calculations of the variance provide uncertain results, as the accompanying tabulation shows.

Calculation	*Dates included*	*Variance ratio*
1	I-567, I-664, M-1089, I-459	9.62
2	I-567, M-1089, I-459	9.90
3	I-664, M-1089, I-459	4.23

These variance ratios indicate that counting errors do exist, and the elimination of the older date does improve the estimate. However, the mean of the average of all the dates, 4121 ± 96 B.C., is only 285 years older than the average of the younger three, 3836 ± 164 B.C., and the result of the elimination of one date or the other under these circumstances is inconclusive. Either one of these averages is useful and we have decided to use the average of all four dates.

The time of the end of the Coxcatlan phase and the beginning of the Abejas phase is rather poorly recorded. The date from Zone Q^1 of Purron Cave, 3897 ± 197 B.C., is an acceptable average of two dates (Table 4, nos. 16, 17). The absence of any sensitive artifact types makes identity of the phase doubtful. However, Zone Q^1 is followed by Zones P and O, for which one can make a tentative guess concerning chronological position. The next date in the series is nearly six hundred years later, and though it was determined on the earliest zone of the Abejas phase, we suspect it may not be quite early enough. The end of the Coxcatlan phase is estimated to be roughly 3400 B.C.

The Abejas Phase

The existence of the Abejas phase is known principally by artifacts found in Zones X, IX, and VIII in Coxcatlan Cave. Artifacts and preserved plant materials from zones in San Marcos, Abejas, and Purron caves, in the Coxcatlan Terrace site, and also from the pit-house site near Chilac (Ts 381e) confirm the inventory from Coxcatlan Cave and add to it occasional examples of crude ovoid end-scrapers, cuboid pestles, small bifacial disks, and stone bowls with flaring rims.

Zones X, IX, and VIII are uppermost in the second division of the stratigraphy in Coxcatlan Cave, beginning with Zone XIV. The three zones were located mainly in the eastern part of the cave and were somewhat different in character from Zones XI below and VII above. Zone X was a very prominent white ash layer capped with a thin layer of charcoal in which preservation of vegetable material was relatively poor. Zone IX was reddish brown and consisted of a large amount of preserved refuse. Zone VIII was dark gray refuse in a layer some 20-40 cm. thick, in which were scattered small, possibly burned, red patches. A thin layer of preserved vegetable material was generally distributed at the top of Zone VIII.

In Abejas Cave, Zone C was found only in the eastern part, and as noted previously, has been classified as late Coxcatlan subphase, possibly transitional to the Abejas phase. Zone B in Fig. 3 is derived from Levels B^2, B^1, and B, field designations of color variations. The fifty-three artifacts of Zone B of Tc 307 which were sensitive types (Table 1) are very similar to those listed for Zone X of Coxcatlan Cave, with some slight suggestion of relationships with Zone XI. Zone C in the Coxcatlan Terrace site, through twenty-seven artifacts classified as sensitive types, can be associated with Zones X, IX, and VIII of Coxcatlan. In addition, it has strong resemblances to Zone D of San Marcos Cave. Tc 254, Zone D, can be located between Tc 50, Zones X and IX, by the distribution of the plant remains and the testimony of a radiocarbon date (Table 5, no. 3). Zone X of Coxcatlan Cave included a cob of an early tripsacoid race of maize not found in Zone D. However proportions of wild to early cultivated maize in Zone D places it after Zone XI of Coxcatlan Cave, and Zone D ends up between Zones X and IX. The radiocarbon date 3300 ± 250 B.C. confirms this location. In summary, Zone B of Tc 307, Zone C of Ts 51, and Zone D of Tc 254 are correlative in age with Zone X of Coxcatlan Cave.

The distribution of artifacts in five Abejas phase levels in Purron Cave is erratic, and they are too scarce to be of great distributional and chronological significance. Zone N with twenty artifacts of eleven types was a layer of compact yellow-brown soil. N^1, a small ash floor to the south, contained two artifacts. Zone M was essentially a layer of rock fallen from the roof

TABLE 4
Radiocarbon Dates from Purron Cave (Tc 272)

Date No.	Location	Date	Date or Average date Selected
		Palo Blanco Phase	
(1)* I-1390	Zone D	2180 ± 190 B.C.	Rejected
(2) I-1391	Zone D	2810 ± 140 B.C.	Rejected
		Santa Maria Phase	
(3) I-771	N2-G	1330 ± 500 B.C.	Rejected
(4) I-568	S4E1-H	250 ± 150 B.C.	445 ± 101 B.C.
(5) I-575	S4E1-H	640 ± 150 B.C.	
		Ajalpan Phase	
(6) I-565	N1-J	1380 ± 170 B.C.	Rejected
(7) I-760	S6E1-J	2350 ± 200 B.C.	Rejected
		Purron Phase	
(8) I-666	S6E1-K^1	1425 ± 200 B.C.	1531 ± 91 B.C.
(9) I-670	S6E1-K^1	1425 ± 170 B.C.	
(10) I-570	N2-K^1	1500 ± 175 B.C.	
(11) I-753	N2E1-K^1	1775 ± 180 B.C.	
(12) I-757	S7E2-K	1900 ± 190 B.C.	1925 ± 131 B.C.
(13) I-762	S7E2-K	1950 ± 180 B.C.	
		Abejas Phase	
(14) I-755	N1E2-L	2725 ± 200 B.C.	2750 ± 136 B.C.
(15) I-572	N1E2-L	2775 ± 190 B.C.	
		Coxcatlan Phase	
(16) I-754	S3E1-Q^1	3850 ± 220 B.C.	3897 ± 197 B.C.
(17) I-768	S1E4-Q^1	3945 ± 200 B.C.	
(18) I-761	S1E4-Q	4400 ± 230 B.C.	4400 ± 230 B.C.
		El Riego Phase	
(19) I-665	S6E1-T	725 ± 180 B.C.	Rejected

*Numbers in parentheses are for text reference.

TABLE 5
Radiocarbon Dates from San Marcos Cave (Tc 254-1)

Date No.	Location	Date	Date or Average date Selected
		Palo Blanco Phase	
(1)* I-657	N1E1-B	A.D. 300 ± 130	A.D. 300 ± 130
		Ajalpan Phase	
(2) I-566	N1E1-C	1025 ± 200 B.C.	1025 ± 200 B.C.
		Abejas Phase	
(3) I-569	N1E1-D	3300 ± 250 B.C.	3300 ± 250 B.C.
		Coxcatlan Phase	
(4) I-573	N1E1-E	4150 ± 200 B.C.	4150 ± 200 B.C.

*Numbers in parentheses are for text reference.

and contained no artifacts. M^1 was either a layer of reddish soil or a layer of disintegrated rock capped by ash covering the southern portion of Zone M; it had no artifacts. Zone L with eight artifacts was light brown silty soil lying on Zones M and M^1. Dog bones in Zone L confirm assignment to the Abejas phase, dating sometime after Zone X.

The list of Abejas phase components is completed by adding the Chilac pit-house site (Ts 381e), from which thirty-eight of the artifacts were divided into twenty-five types, some of which are diagnostic of the late Abejas subphase.

The date on Zone X of Coxcatlan Cave, 3075±180 B.C. (Table 2, no. 18), has been accepted as a general indication of its age, even though the Abejas phase may have developed out of the Coxcatlan phase some four hundred years earlier. Three zones from three other sites appear to be correlative with Zone X and are considered to be approximately contemporaneous because, as noted, they have similar inventories. Zone D of San Marcos Cave produced such artifacts as cuboid pestles, large bifacial disks, and fine blades. This zone may be the earliest one in the Abejas phase, for it is dated at 3300±250 B.C. (Table 5, no. 3) by a single sample comprised of palm leaves, fibers, and wood. The second zone of this group is Zone C of Coxcatlan Terrace, upon which we have no radiocarbon date. The third is Zone B of Abejas Cave, and there are four dates from its combined levels (Table 3, nos. 1-4). One, 1310±150 B.C., is rejected because it is too young to be at all useful. The remaining three are all relatively old, the average being 4962±188 B.C. The range of these is within that of two sigma and the average is nearly 900 years older than the mean of the date of Zone X in Coxcatlan Cave. We are therefore rejecting the dates, despite the fact that they appear in a reasonable order in the cave itself. It may be observed that Tc 50, Zone X, is rather well defined and Tc 307, Zone B, relatively poorly so by the sensitive artifact types (Table 1). However, nineteen of twenty-one types of artifacts in Zone B duplicate types in Zone X, where all told there are fifty types. This correspondence suggests that the two zones are very close. The three dates on Zone B, taken singly or averaged, place the levels between Tc 50, Zones XV and XIV (Fig. 3), and the combined occupation would perforce be classified as El Riego phase. The inventory of sensitive artifact types, incomplete though it is, does not permit this.

Zones N^1 and N of Purron Cave appear to fall slightly later and are correlated with Zone IX of Coxcatlan Cave, which is dated by an average of three dates at 3183±112 B.C. (Table 2, nos. 15, 16, 17). This average was derived from dates on five samples. We have rejected I-677 (Table 2, no. 13) because the variance ratio indicates counting errors. I-763 (Table 2, no. 14) is so far out of line that rejection is inevitable. The dates accepted were on three samples from floor 16 of Zone IX, two of them coming from Square S2E10 and the third from an extension of floor 16 into the adjoining Square S2E11. These dates overlap in the one sigma range and the date is acceptable.

Zone M at Purron Cave has no sensitive artifact types, but Zone L has paint palettes and rubbed pebble polishers, as does Zone VIII of Coxcatlan Cave (Table 1). Zone VIII was a well-defined one in the Coxcatlan deposit. There are two dates, 3200±220 B.C. and 2820±175 B.C. (Table 2, nos. 11, 12), which overlap in the range of one sigma. The samples were comprised of pieces of charcoal which were concentrated out of the debris of the zone; no hearth was mentioned. There are no archaeological exceptions to the date or the position in the sequence. The dates are compatible, and the average, 3010±140 B.C., is acceptable. Zone L at Purron Cave has an average date 2750±136 B.C. (Table 4, nos. 14, 15). That Zone L may possibly occupy the latter part of the time span of Zone VIII or be even later is suggested by the presence of the two later types of artifacts mentioned above.

The sequence of Coxcatlan Cave appears to be interrupted above Zone VIII. The transition from preceramic to ceramic periods is seen only in the sparse collection from two levels at Purron Cave. Eight hundred and twenty-five years separates the means of the dates on Zones L and K at Tc 272. We have chosen arbitrarily an intermediate date, 2300 B.C., for the end of the Abejas phase and the beginning of the Purron phase.

The Purron Phase

Information concerning the Purron phase is indeed scarce for reasons which are as yet obscure. At Coxcatlan Cave, Purron phase materials should have appeared above Zone VIII, but instead there is a gap in the continuity of occupation, for the overlying Zone VII was not deposited until late Santa Maria times. The only information concerning the Purron phase comes from Zones K and K^1 in Purron Cave. Zone K consisted of a very fine-grained silty soil upon which lay a discontinuous, sometimes thin layer of charcoal and ash. This layer was complicated in sections by increments of charcoal, variations in thickness, and the presence of laminations of charcoal and yellow soil. These overlying complications were called Zone K^1. Zone J, closely related to K and K^1 but apparently a little later in time, was a darker brownish-gray layer that became more deeply red in color toward the top where a well-defined deposit of ash and burned earth included preserved vegetable material.

The earliest and also crudest pottery from the Tehuacan Valley was found in Zones K and K^1, along with fragments of oblong manos, saucer-shaped metates, and fine blades with prepared striking platforms. These types are later than materials in Zone VIII of Coxcatlan Cave but precede the more complex artifact assemblage of Zone VII.

Dating the Purron phase with any degree of confidence is foiled by the lack of cultural materials permitting satisfactory comparison and placement in the sequence. The end of the Abejas phase and the transition to Purron is marked by the appearance of pottery in the valley. Zone L of Purron Cave contained none of the crude pottery and was dated 2750±136 B.C. (Table 4, nos. 14, 15). A hearth from the overlying Zone K produced a date of 1925±131 B.C. (Table 4, nos. 12, 13). Since the difference between the means of the dates for the two levels is 825 years, and the standard errors fail to overlap by several hundred years even in the two sigma range, we propose an intermediate date for the transition from Zone L to Zone K. In view of the similarity and probable age of Pox pottery from the Guerrero coast (Brush 1965) and the probability of cultural connection (Table 9 and Fig. 4) we estimate that the transition from the Abejas phase to the Purron phase took place about 2300 B.C.

The date on Zone K^1 of 1531±91 B.C. (Table 4, nos. 8-11), the mean of four dates ranging over 350 years, has a mean which is 400 years later than the date on Zone K, its closely associated predecessor and 261 years earlier than the date of the lowest level of the Ajalpan site, 1270±130 B.C. (Table 6, no. 12), which succeeds it in the sequence. This record shows a spread of 1480 years in the means of the dates on zones between the last date in the Abejas phase and the first date in the Ajalpan phase, into which span the Purron phase is fitted. The dates on the two zones in the Purron phase are more widely spaced than is to be expected, but this is perhaps an indication that the phase may have lasted an appreciable length of time. An estimate that the transition to the Ajalpan phase commenced about 1500 B.C. is largely a guess, but it is substantiated in a negative way by comparative data from neighboring areas. The several types of Ajalpan pottery usher in the Ajalpan phase. They are also characteristic of the bottom of a number of sequences in surrounding areas, although none of the latter are quite as early as Ajalpan in the Tehuacan Valley.

The Ajalpan Phase

The distribution of pottery types from the Purron phase to the Ajalpan phase demonstrates a continuity in development in more detail than can be seen in the sequence of stone artifact types. The field research revealed the transition in Purron Cave from Zone K^1 to Zone J, where Ajalpan ceramic types began to appear. The basic stratigraphic investigations, however, were forced to move from the cave sites to the open sites — Ajalpan (Ts 204), Coatepec (Ts 368e and 368w), and Canoas (Ts 367), all located in the Ajalpan clay-pit area — and eventually for later materials westward to the Quachilco site (Tr 218). This shift was due largely to a growing dependence on agriculture and the migration of the population from the caves to small wattle-and-daub villages located in the valley's center and near the fields which produced the crops upon which the people depended for food. As a result of this shift, we find that Coxcatlan Cave no longer is a key to the sequence of the valley, for it was not occupied for more than two thousand years between the abandonment of Zone VIII and the accumulation of Zone VII. The stone artifact and pottery sequences uncovered in the open sites now provide the framework for chronological interpretations.

Radiocarbon dates do not supply a detailed measure of time for this early Formative period, because they lack the necessary sensitivity to permit definition of the small units of time during which the zones were occupied. Within the span of time from about 1500 B.C. to about 600 B.C. the two sigma ranges of all the dates overlap each other, and there is a very large proportion of overlap in the one sigma range as well (Figs. 2, 3). The dates cannot be used to establish the detailed chronology of the zones of the Ajalpan and early and middle Santa Maria phases, nor to check the order of them in seriation. Statistical analysis of the variance of both ceramic and nonceramic artifacts in the zones indicates the detailed seriated order is questionable in minor instances. The suggested changes in order, however, do not materially affect phase designation or even ideas concerning cultural development. They possibly could have some bearing upon the particulars of trade relationships and cultural diffusion involving details of sequences in neighboring regions.

Although the beginning of the Ajalpan phase can be seen with some clarity in the sequence of pottery types, and less clearly but as positively in the distribution of stone artifacts, the date of the transition is not satisfactorily identified. There is a difference of 260 years between the means of the latest date on a Purron phase sample (Tc 272, Zone K^1) and a date on Zone H of the Ajalpan site, a presumed primary level in Ajalpan. Also we have called attention to the estimated but unauthenticated long span of time postulated for the development of Purron. These observations lead to an opinion that the estimate of 1500 B.C. for the beginning of Ajalpan is a useful approximation, but it needs to be confirmed.

The principal information concerning the Ajalpan phase, particularly early Ajalpan, comes from two sites in the Ajalpan area, Ts 204 and Ts 204D. Deposition at Ts 204 commenced in a natural hollow in the original surface, and during its life the site was abandoned during short periods of flooding. These floods left thin laminae of clay in the accumulating deposit of fine silt and occupational debris. The latter comprised a series of layers and floors containing varying amounts of charcoal, burned clay, and other refuse. Preservation was poor in these levels and no vegetable material was recovered. The lowest occupied level, Zone H, covered the bottom of the depression. Succeeding floors and levels were designated Zones G, G^1, F, F^1, E, D, and C. On the basis of pottery types, especially the developing importance of the Coatepec wares, the transition of early Ajalpan to late Ajalpan takes place between Zones G^1 and F. The site was abandoned for a considerable length of time between the termination of the deposition of Zone E and the accumulation of the laminated deposit called Zone D. The latter was covered by Zone C, which was of similar character.

Ts 204D was very similar to Ts 204 except that it did not accumulate in a depression. Zones A and B produced pottery types characteristic of the Santa Maria phase, but the lower zones — a series of levels of refuse, burned floors, and zones of charcoal — contained materials characteristic of the late Ajalpan subphase.

Late Ajalpan materials were found also in the lower levels of the Coatepec site, which was a huge mound of refuse, the eastern excavation at which (Ts 368e) was in the midden. The western sector of the midden deposit included a small stepped pyramid (Ts 368w). Because of the depth of the refuse in the eastern site, the trenches were stepped down as they expanded both east and west and north and south, a routine procedure which is more complicated to describe than to accomplish. Zone K underlay the whole site. It was a thick deposit, which because of the color and other variations was divided into three subzones, K^3 being the lowest, succeeded by K^2 and K^1. The deposit was composed of sandy clay or silt in which there were various patches of ash and a few pits. Zone K^1 was a well-defined reddish brown silty clay on which lay two patches of ash which were house floors. Above it Zone J was a distinctive layer of brown soil.

At San Marcos Cave (Tc 254), Zone C was found to include some late Ajalpan types of artifacts. The zone was divided during excavation into C^1, scaly rock from the roof lying on Zone D, and C itself, a capping of refuse which covered much of the cave. A date on Zone C is 1025±200 B.C. (Table 5, no. 2).

Zone J of Purron overlay Zone K^1 and was composed of a light brown or yellowish silty layer. The ceramic and nonceramic artifacts indicate its resemblance to Zones G and H of Ts 204. The date on Zone J, 1380±170 B.C. (Table 4, no. 6), is unfortunately unacceptable because the sample may have been mixed with material from overlying Zone I. A second date, 2350±200 B.C. (Table 4, no. 7), is too old to fit in the established sequence and has been rejected. However, the date must not be ignored. It may indicate not only that Zones J and K are closely related, as an interpretation of the cultural data would have it, but also that the zones may be of similar ages. Zone H of Ajalpan has in common with Zone J of Purron fine blades with prepared striking platforms, ovoid manos, and mullers and milling stones. Zone G of Ajalpan has most of these traits and in addition still other types represented in Zone J of Purron: square-poll celts, long plano-convex manos, oblong manos, and flake choppers. The contemporaneity of the three zones deduced from these similarities is belied by the presence, in Ts 204, Zone H, of Zacatenco points, bell-shaped pestles, fine end-scrapers, and truncated-cone pestles. Abrader saws and square-poll celts in Ts 204, Zone G may indicate that Ts 204 components are later than Zone J of Purron, perhaps being contemporaneous with Zone E of Ts 204D.

The early Ajalpan dates were all determined on levels in Ts 204, and they pose a problem in interpretation. I-912 (Table 6, no. 13) is obviously in error and is rejected. Sorting out the other dates for Zone H becomes a matter of judgment. Comparison of standard errors and other attempts to establish validity indicate irregularities, and it is likely that these are due to the method of collection. The date 625±160 B.C. fails to overlap 1270±130 B.C. (Table 6, nos. 11, 12) in the range of two sigma. Zones H and G of Ts 204 has many similar artifacts and much in common with Zone J of Purron. Statistical comparison shows that Zones H and G may be slightly later than Zone J of Purron and that similarities indicate connection with Zone E of Ts 204D.

The date 1150±140 B.C. (Table 6, no. 10) may in-

TABLE 6

Radiocarbon Dates from the Ajalpan Site (Ts 204) and Burial Pit (Ts 204C)

Date No.		Location	Date	Date or Average date Selected
		Ajalpan Phase		
(1)*	I-927	E1-F¹	1090 ± 300 B.C.	980 ±157 B.C.
(2)	I-752	S5E3-F¹	1050 ± 350 B.C.	
(3)	I-924	E2-F¹	800 ± 130 B.C.	
(4)	I-920	E1-F	635 ± 140 B.C.	Rejected
(5)	I-923	E4-F	915 ± 130 B.C.	972 ± 92 B.C.
(6)	I-935	E4-F	1030 ± 130 B.C.	
(7)	I-901	E6-G¹	860 ± 120 B.C.	1218 ± 108 B.C.
(8)	I-895	E4-G¹	1575 ± 180 B.C.	
(9)	I-926	E5-G	650 ± 150 B.C.	Rejected
(10)	I-934	E9-G	1150 ± 140 B.C.	1150 ± 140 B.C.
(11)	I-595	S5-H	625 ± 160 B.C.	Rejected
(12)	I-929	E7-H	1270 ± 130 B.C.	1270 ± 130 B.C.
(13)	I-912	E4-H	A.D. 1250 ± 200	Rejected
(14)	I-767	Pit	900 ± 190 B.C.	900 ± 190 B.C.

*Numbers in parentheses are for text reference.

dicate the age of Zone G. However, caution in acceptance is necessary for the sample which was dated was a very small one. The date does overlap the date chosen for Zone H, and as implied by the seriation, this may mean that the two zones were not very different in age. The date 650±150 B.C. (Table 6, no. 9) has been rejected because it does not fit the sequence and because of the possibility of contamination of the sample with materials from a lower level.

The significance of the two dates on Ts 204, Zone G¹ (Table 6, nos. 7, 8), is uncertain. One of them, 1575±180 B.C. was determined on a sample taken from a heavily burned area, and there may have been old wood in this fire. The other, 860±120 B.C., was determined on a very small sample and is subject to errors because of this. The average of the two, 1218±108 B.C., is shown as the selected date for the zone, but is not very satisfactory because of the great difference in the means. Taken at its face value, the date supports the seriation in implying that there may not be much difference in time between Zones H, G, and G¹, but it does not reflect the close relationship with overlying zones implied by the distribution of the cultural data.

The late Ajalpan subphase commences with Zones F and F¹ of Ts 204 and Zone E of Ts 204D, the latter having no radiocarbon date. The three dates from Zone F (Table 6, nos. 4, 5, 6) present a problem analogous to the series from Zones G and G¹. The average for all three dates is 860±77 B.C., but this is not the assigned date for the zone. Averaging various combinations of the three dates results in means which vary only by an insignificant ninety-eight years. However, one of the dates, I-920, was determined on a very small sample, which could account for its variation with the other two dates, and so it is rejected. In view of the seriated sequence and the character of the trade sherds found in the zone, we have accepted the average of the other two dates, 972±92 B.C., as indicative of the age of Zone F.

Three dates from Ts 204, Zone F¹ are not evenly distributed in their range, there being a difference in the means of about 300 years (Table 6, nos. 1, 2, 3), a figure which is probably larger than the actual life-span of the zone. The errors on two samples, which were small-sized ones, are large, thus frustrating a close estimate of age. The average of the dates, 980±157 B.C., is probably a little too old, but the figure is generally usable.

We are not particularly happy about these arbitrary decisions, because they are not strongly supported by the radiocarbon dates. The seriation of artifacts and also the statistical analysis show that the artifact distribution also fails to suggest a restricted distribution and alignment of the levels. The compromise suggested here, and set forth in Fig. 3, is supported by dates and seriations in neighboring regions (Fig. 4). The position of Zone E of Ts 204D is uncertain because it could be as early as Zone G in Ts 204. However, we have aligned it with succeeding Zones F and F¹ of Ts 204 because it has types in common with them and with Zone C of San Marcos. Zone C of San Marcos, according to the seriation, which is supported by the computer analysis, can only appear in the range of zones later than Zones G and G^1 of Ajalpan. The date of Tc 254, Zone C, 1025±200 B.C. (Table 5, no. 2), places it in the age range of Zones F and F^1 of Ts 204; perhaps it could occupy the earlier part of the period.

Ts 204C was a burial pit a short distance from the main Ajalpan site, Ts 204. The date 900±190 B.C. (Table 6, no. 14) is on charcoal found in the burial in direct association with a large hollow dwarf figurine. The burial pit had been dug down from a stratum that seemed equivalent to Zone E of the main site and that definitely lay beneath Zone C-D, present in both sites. The stratigraphy renders the date quite acceptable and the pit appears as a very late Ajalpan time marker.

The lower levels of the Coatepec site (Ts 368e) have been classified as late Ajalpan mainly because of the distribution of the ceramics, especially the high proportions of Coatepec Plain, Ajalpan Coarse Red, and Coatepec Buff. The upper two of these levels, Zones K^1 and J, appear to be slightly later than Ts 204C and the latest levels at Ts 204D and are the final occupations of the Ajalpan phase at Coatepec. The dates on Zones K^1 and J, 708±71 B.C. and 803±89 B.C. respectively (Table 7, nos. 22-26), indicate the time of the ending of this phase. In view of these, and of dates on the primary levels classified as the following Santa Maria phase, the evidence solely from radiocarbon is that 800 B.C. would be a reasonable estimate for the time when the change from one phase to another took place. However, additional evidence, mainly types of pottery and comparative data from outside the valley, must be taken into account as will be explained below.

The Santa Maria Phase

The beginning of the Santa Maria phase is clearly marked by the appearance of clusters of new pottery types in significant amounts in Zones H and I of the east end of the Coatepec site and by the arrival in the Tehuacan Valley of several contemporary types of pottery which originated outside the region. These two earliest Santa Maria levels are dated 766±68 B.C., an average of four dates for the lower zone (Table 7, nos. 18-21), and 842±75 B.C., an average of three dates for the upper zone (Table 7, nos. 15-17). These dates suggest 800 B.C. as the beginning of the phase, since it is in the range of one sigma of all seven dates and the two averages overlap the suggested date also in the range of one sigma (Table 9, nos. 66, 67). However, other evidence — dates for levels in Ts 204D and for Ts 204C, part of the final components of the late Ajalpan subphase; the proportional distribution of new and old pottery types in Ts 204C and Zones H and I of Ts 368e; and the correlation of pottery types and dates from the related Cuadros, San Jose, and San Lorenzo phases of Guatemala, Oaxaca, and Veracruz — indicates that the Santa Maria phase in the Tehuacan Valley may have begun about 850 B.C.

The date for the end of the Ajalpan phase and the beginning of Santa Maria cannot be determined with any reasonable degree of certainty. The time span involved is too short to be defined by radiocarbon. It amounts to less than one hundred years and the standard errors from Tehuacan, Guatemala, Oaxaca, Veracruz, and Chiapas range between about ±60 for averages of means of groups of three or more dates on a single sample and ±150 for the average of means on single determinations. Though the distribution of pottery types through time and space appear to be clear, it indicates broadly correlation of phases and a sequential arrangement of them, but it is not an indicator of the details of chronology. There is no question that the Santa Maria phase in the Tehuacan Valley commenced immediately following a short period limited by the age of the burial pit, Ts 204C, and including zones K^1 and J of Ts 368e. This period was concluded by the beginning of the deposition of Zones H and I in Ts 368e. The radiocarbon dates and the physical stratigraphy, to be described in a little more detail below, indicate that the two latter zones, and as a matter of fact, Zone J, occupied a relatively short span of time.

In regard to the correlation of ceramics from outside the valley, the assumption of contemporaneity of appearance of certain "trade" wares in, say, Chiapas and Tehuacan, is a necessary one. At this writing, however, we have no knowledge of the social, economic, and political relationship between the two regions, and we lack information concerning factors of diffusion which must have been in effect. There must have been some time involved in the exchange of pottery types between regions — particularly of correlative types that appear indigenously. Presumably the time was short, but even half a generation would nullify the fifty years difference which presently exists in our estimates. Suffice it to say that consideration of all available information leads us to an estimate that the beginning of the Santa Maria phase is slightly older than the average of the dates from the Tehuacan Valley and occurred about 850 B.C.

We have mentioned that the time span between Ts 368e, Zones J and I, is so short that available radiocarbon dates are not sensitive enough to establish the details of the chronology of the zones. The soil and content of Zones I and H were similar in character to the preceding deposits. The following Zone G was very

TABLE 7
Radiocarbon Dates from the Coatepec Site (Ts 368e)

Date No.	Location	Date	Date or Average date Selected
		Santa Maria Phase	
(1)[*] I-918	S2E4-B	45 ± 100 B.C.	45 ± 100 B.C.
(2) I-907	S2E5-C^1	690 ± 140 B.C.	608 ± 92 B.C.
(3) I-894	S1-C^1	525 ± 120 B.C.	
(4) I-933	S2E5-C^2	635 ± 130 B.C.	635 ± 130 B.C.
(5) I-930	S2E4-C^2	1150 ± 150 B.C.	Rejected
(6) I-898	N1-D	800 ± 150 B.C.	718 ± 99 B.C.
(7) I-905	S2E4-D	635 ± 130 B.C.	
(8) I-906	S2E4-E	915 ± 140 B.C.	765 ± 77 B.C.
(9) I-922	S1-E	690 ± 130 B.C.	
(10) I-913	S2E5-E	690 ± 130 B.C.	
(11) I-910	S2E4-F	690 ± 130 B.C.	775 ± 92 B.C.
(12) I-919	S2E5-F	860 ± 130 B.C.	
(13) I-932	S1-G	1150 ± 150 B.C.	Rejected
(14) I-897	S2E5-G	1030 ± 190 B.C.	Rejected
(15) I-925	S1-H	635 ± 130 B.C.	842 ± 75 B.C.
(16) I-903	S2E4-H	915 ± 130 B.C.	
(17) I-904	S2E5-H	975 ± 130 B.C.	
(18) I-909	S2E5-I	690 ± 130 B.C.	766 ± 68 B.C.
(19) I-900	S2E4-I	775 ± 130 B.C.	
(20) I-928	N1-I	800 ± 130 B.C.	
(21) I-896	S1-I	800 ± 150 B.C.	
		Ajalpan Phase	
(22) I-915	N1-J, S1-J	745 ± 120 B.C.	803 ± 89 B.C.
(23) I-931	S2E5-J	860 ± 130 B.C.	
(24) I-916	N1-K^1	690 ± 120 B.C.	708 ± 71 B.C.
(25) I-914	S2E5-K^1	745 ± 120 B.C.	
(26) I-908	S2E4-K^1	690 ± 130 B.C.	

[*] Numbers in parentheses are for text reference.

distinctive, being composed of ash, brown silt, chunks of wattle and daub, and gravel. Probably this material was dumped there during a process of house leveling and general cleaning and remodeling of the site. Two dates on Zone G have been rejected (Table 7, nos. 13, 14) because, even though they are consistent within themselves, they are much too early to be in line with the seriation. The ceramics of Zone G are nearly the same as those of Zones H and I.

Although the nonceramic artifact samples are not large, the samples of sherds are sizeable from Coatepec Zones F-D and link these zones with Zones C, D^1, and D^2 of Las Canoas. Zones I and H of Purron also have similar inventories. Although alignment cannot be positively established, the dates are of some assistance as described below and particularly as listed in Fig. 3.

Zone F of Coatepec, dated 775±92 B.C. (Table 7, nos. 11, 12) followed the period of house leveling. It was capped by a thick layer of charcoal and paving stones. Four later zones were composed of various colored layers of soil and refuse with here and there areas of chunks of wattle and daub and a few post molds. Four averages of nine dates for Zones E, D, C^2, and C^1 range from 765±77 B.C. to 608±92 B.C. (Table 7, nos. 2-10). These are consistent with the sequence of the zones and the span of about 150 years indicated by the means is acceptable. In view of the standard errors, however, the lengths of time the zones were occupied are too short to be measured in detail by the radiocarbon technique.

The lower three zones at the Las Canoas site were identified as belonging to the early Santa Maria subphase. Zone D^2 was a dark sandy clay including chunks of wattle and daub. Zone D^1 was a sandy clay including many flecks of charcoal. It was capped by a thin charcoal layer in the northern sections. Zone C was a com-

TABLE 8

Radiocarbon Dates from the Las Canoas Site (Ts 367)

Date No.	Location	Date	Date or Average date Selected
		Santa Maria Phase	
(1)[*] I-902	N5-C	635 ± 150 B.C.	775 ± 106 B.C.
(2) I-899	N4-C	915 ± 150 B.C.	
(3) I-917	N3-D^1	635 ± 130 B.C.	608 ± 87 B.C.
(4) I-893	N2-D^1	580 ± 120 B.C.	
(5) I-911	N3-D^2	635 ± 130 B.C.	635 ± 130 B.C.

[*] Numbers in parentheses are for text reference.

pact yellow and brown soil which included a large amount of charcoal and refuse even though it did not appear to have actually been occupied. The surface of this zone was prominent for it had been modified during a long period of exposure before the accumulation of Zone B commenced.

The dates on zones at the Las Canoas site are not definitive. The date on Zone D^2, 635±130 B.C. (Table 8, no. 5), was determined on a sample which was a combination of charcoal from Squares N3 and N2. The date is within a one sigma range of the average for the zone lying above it, and it is assumed that the age is a good estimate. The 280-year range in age suggested by the means of two dates on Zone C (Table 8, nos. 1, 2) is a relatively long span of time compared to the probable life of these zones, and one is tempted to reject the date 915±150 B.C. as being too old, although there is no technical reason for this assumption. However, the average date, 775±106 B.C., for Zone C overlaps the date on Zone D^1 in the range of one sigma, and so this average is retained despite its marginal position.

Early Santa Maria materials were also found in Zone I at Purron Cave. This zone was a cream-colored layer of silt, the upper part of which was heavily burned. Above it, Zone H, from the end of early Santa Maria — or at the beginning of late Santa Maria — dated about 445±101 B.C. (Table 4, nos. 4, 5). This zone was a prominent layer that covered the whole of the cave floor. The overlying Zone G was similar to Zone H, but was more reddish in color, and in the north end of the cave preserved vegetable materials, seeds, and charcoal lay upon its surface. Zone G is classified by its artifacts and plant remains as late Santa Maria; a date on the zone is much too old, however, and is rejected (Table 4, no. 3). The date for Zone H indicates that the transition from the early Santa Maria subphase to the late subphase occurred about 500 B.C. Zone B at Coatepec (Ts 368e), classified as late Santa Maria, was refuse and soil with some layers of ash and charcoal and an occasional floor resulting from concentrated occupation. The date from Zone B, 45±100 B.C. (Table 7, no. 1), was determined on a large and acceptable sample. It is really too young, but it has been retained even though its consistency with the sequence is marginal.

Ts 368w is the western portion of the large midden called Coatepec in which a test trench struck the edge of a small stepped pyramid. The structure was covered with an accumulation of stratified refuse. Zones D and C, accumulations of brown soil and refuse, filled the area to the top of the pyramid, which was covered by Zones B and B^1, made up of various silts and refuse. These layers in turn were covered by gray-brown soils connected with Zone A of the whole area. The similar lettering of the zones in the two parts of the site can be confusing because zones in the west are not contemporaneous with similarly lettered zones in the east.

Zones A and B of the Ajalpan site (Ts 204) have been classified as late Santa Maria. These were the uppermost levels at the site and were composed of sandy silt divided into two members by a thin layer of sandy gravel, which may have developed while the lower layer lay exposed for some time. There are no radiocarbon determinations for these levels.

Zone VII at Coxcatlan Cave included late Santa Maria types of artifacts and pottery. The zone marks the reoccupation of the cave following a long period during which it was abandoned. These late deposits comprise a sequence of zones of ash and cave dirt usually capped with a floor of vegetable material. A pit in this zone produced a sample which was dated 2850±200 B.C. (Table 2, no. 10). The date is much too old for the types of associated materials and is rejected.

Quachilco (Tr 218) is an extensive site on the plains of the valley west of the Ajalpan sites. Occupation of the site commenced in late Santa Maria times and was abandoned during early Palo Blanco times. Some thirteen test excavations and trenches were dug in and around ruined pyramids and in the plaza. Different numbers of zones were identified in the trenches, varying from three or four to as many as seven. All except the surficial Zone A included late Santa Maria ceramics. Zone A is classified as early Palo Blanco. No dates were determined for this site, but it quite clearly was inhabited for a short span of time, possibly only a century or two.

The late Santa Maria subphase seems to have ended about 150 B.C. This assumption is based on the estimate of a short span for the phase, on the early Palo Blanco date, A.D. 180±100 for Zone VI of Coxcatlan Cave, and on correlations of comparative materials from surrounding areas.

The Palo Blanco Phase

It has been noted that Zone A of at least three trenches in the Quachilco site was classified as early Palo Blanco. This zone, together with Zone A of Abejas Cave are the initial ones in the Palo Blanco phase. A number of traits — blades with ground striking platforms, cuboid manos, and Teotihuacan, Palmillas, and Tehuacan points — first appear in these levels. The pottery types El Riego Black, El Riego Polished, El Riego Plain, El Riego Orange, Thin Orange, and Coxcatlan Brushed also appear for the first time early in the Palo Blanco phase.

Zone F of Purron Cave is closely related to the levels mentioned, and Zones E-A are a little later, though as yet undated. The latter were layers of refuse combined with soil and contained occasional large roasting pits. Zones D and E are classified as early Palo Blanco, and Zones A-C are late Palo Blanco.

Zones A and B of Coxcatlan Terrace, two members of a relatively deep deposit including particularly a miscellaneous mixture of stone artifacts, relate closely to Zone F of Purron and thus fall early in the Palo Blanco phase.

Zone VI of Coxcatlan Cave, an early Palo Blanco level, was comprised of thin layers of ash overlain by a thick layer of vegetable material. There are two dates, one from a sample from a floor in the zone and the other from a burial which probably was associated with the zone (Table 2, nos. 8, 9). Because of the difference in the means, the average of these two dates is hardly satisfactory, even though it is in line with the other dates. What is more likely is that the sample of cloth from the burial dated A.D. 5±200 was an "antique" and that A.D. 180±100 is a more acceptable date for the floor of Zone VI from which the sample was collected.

Zone V of Coxcatlan Cave was a layer of ash and preserved plant remains in the east end of the cave. Two dates, A.D. 325±120 and A.D. 50±150 (Table 2, nos. 6, 7), were determined on a single large sample. The difference, 275 years, is just barely in the one sigma range and can hardly be considered satisfactory. The average, A.D. 187±96, places Zone V very close to Zone VI in time. That this may be true is borne out to some degree by the nonceramic artifacts for both zones, which include Palmillas points. But the pottery types, though similar, show a slightly different distribution, placing Zone V in the late Palo Blanco subphase.

Zone IV of Coxcatlan Cave, extending from east to west, comprised a lower layer of ash and an upper layer with a large proportion of plant remains. A date on the zone, A.D. 325±150 (Table 2, no. 5) is satisfactory. The zone is also classified as a late Palo Blanco component. It included a fine blade with a ground striking platform, a tool which became common in the succeeding Venta Salada phase. Zone A of Purron Cave and Zone B of San Marcos have similar blades with ground platforms as well as a similar distribution of pottery types.

In San Marcos Cave Zones C^1 and B were rich layers of vegetable material. The date on a sample from Zone B is A.D. 300±130 (Table 5, no. 1). This date and the contents of these levels place them in the late Palo Blanco subphase.

Additional zones assigned to the late segment of the Palo Blanco phase are Zone 4 from the West Niche of El Riego Cave and Zones F, E, and D from the cave's East Niche. These zones were layers of dirt and refuse which were clearly definable even though somewhat irregular. Another deposit, Zone B of Tecorral Cave (Tc 255), also included artifacts diagnostic of late Palo Blanco.

There are no dates from the Tehuacan Valley which would give a clue to the precise age of the end of the Palo Blanco phase. However, the comparative material discussed below (Table 9 and Fig. 4) indicates that A.D. 700 is a reasonable estimate, although possibly a century or so too late.

The Venta Salada Phase

Venta Salada phase materials were found in the upper levels of most of the excavated sites. Zones B and C of the East Niche of El Riego Cave are early Venta Salada subphase and Zone A is of the late Venta Salada subphase. Other early Venta Salada components are Zones II and III of Coxcatlan Cave, Zones 2 and 3 of the West Niche of El Riego Cave, and Zone A of San Marcos Cave. Late Venta Salada levels are Zone 1 of El Riego's West Niche, Zones A and B of Las Canoas, Zone I of Coxcatlan, and Zone A of the East Niche of El Riego, and of both the east and west sections of Coatepec, and of course, a great many sites identified during reconnaissance. It includes also the two single-component excavated sites, Tr 62 and Tr 65.

The upper zones of the excavated sites were the surficial ones and varied from levels of cave dirt and refuse covered with goat dung to the gray sandy or gravelly silts including rubbish of the open sites. Actually the upper zones are very difficult to align exactly because of the overlapping of types of stone artifacts and pottery. Even the statistical analysis is inconclusive.

The Venta Salada phase follows directly on late Palo Blanco about A.D. 700 or possibly earlier. The only dates from the Tehuacan Valley are from zones in Coxcatlan Cave. Zone III, early Venta Salada, is dated at A.D. 900±110 (Table 2, no. 4). The means of three dates from Zone II vary from A.D. 900 to 1300. One date A.D. 1175±100 (Table 2, no. 3) is in an acceptable range. The other two dates, A.D. 900±120 and 1300±100, are two determinations on the same sample which was divided before being submitted to the laboratory. The difference in the mean of 400 years and the fact that the dates just barely overlap in the range of two sigma renders suspect the average, A.D. 1100±78, at least for the detailed purpose. Although we retain the average date in the tables, we recognize the possibility of contamination of the sample, especially in a deposit so close to the surface. The Venta Salada phase was ended before A.D. 1600 by the Spanish Conquest of Mexico.

A Chronology for Mesoamerica with Special Reference to the Tehuacan Valley

In the previous section we have discussed the radiocarbon dates of the archaeological zones in the Tehuacan Valley and, mainly on the basis of the field data, we have selected those dates which are useful in establishing the chronology of the zones and of the cultural phases and subphases. In volumes 2 and 3, the archaeological phases in the Tehuacan Valley are defined and their relationships to comparable units in Mesoamerica indicated.

Many phases in many parts of Mesoamerica have been dated by radiocarbon or other means. It is our intention in this section to correlate these dates with the established chronology of the Tehuacan Valley. We shall utilize correlations of indigenous and traded materials in order to produce estimates of the chronology of the dated zones and also of zones for which there are no acceptable radiocarbon dates. This complicated system of analysis provides comprehensive chronological estimates for units in the archaeological sequences of the whole area. As a result we should find ourselves in a better position to understand various problems relative to cultural development, including its rate and diffusion.

In order to reduce the complications in the record of nearly 400 radiocarbon dates and about 145 phases or complexes, we shall consider each Tehuacan phase in turn, discussing the dates of each and comparing these with dates of related cultural phases. We shall also correlate Tehuacan zones with foreign ones by recording the presence of similar artifacts and noting especially the presence in Tehuacan levels of artifacts, mainly potsherds, of foreign origin. It is reasonable to assume that potsherds found in the valley, but manufactured in neighboring areas, are there as a result of economic, political, and social relationships between the regions involved. We have also assumed that a foreign potsherd in a Tehuacan zone indicates contemporaneity between the zone and the phase of origin of the sherd. This combination of artifact comparison and correlation and radiocarbon dating, often called "cross-dating," does no violence to the chronology because the lags in times involved in the diffusions of the "trade sherds" are likely to be of a smaller order than the errors in the estimates of the dates involved.

It is wise to repeat a warning voiced in a previous section. The broad significance of a date in sequence with other dates in a chronology can be easily interpreted. However, its chronological meaning relative to a level or zone, and even to a phase or complex, is not as specific as it may appear. A level or zone is deposited over a period of time. Only very rarely have a sufficient number of dates from critical locations within a zone been determined so to indicate the length of time during which the zone existed; when it began and ended. The same problem exists in determining the beginning and end of phases. It is impractical to qualify this uncertainty every time estimates of the age of a unit are offered; thus our presentation of the data may appear to be more precise than the evidence justifies.

Table 9 and Fig. 4 are intended to assist in understanding the significance of the dates and to provide complete records of them short of descriptions of the samples. We have not cluttered the text with references to the dates other than to give an index number for each, which refers to dates listed in Table 9. Dates quoted but not recorded in Table 9 are followed by the conventional date number assigned by *Radiocarbon*,

TABLE 9
A Chronological Chart of Mesoamerica

(Date and complex are keyed to Figure 4)

Date No.	Date	Complex	Key	Reference
		Ajuereado Phase		
(1)* L-161	7300 ± 250	Ixtapan mammoth	M19-A	Thurber corres., 1967
(2) M-776	7720 ± 400	Assoc. with mammoth	M19-B	*Radiocarbon* 2:44
(3) M-499	7320 ± 500	Lerma	N8-1	*Science* 127:1103
		El Riego Phase		
(4) I-764	6475 ± 250	El Riego	L12-1	*Radiocarbon* 11:92
(5) I-461, I-769	6513 ± 186	El Riego	L12-2	Ibid.:89, 92
(6) I-758	6040 ± 300	El Riego	L12-3	Ibid.:96
(7) I-759	6040 ± 225	El Riego	L12-4	Ibid.
(8) I-658, I-765	5850 ± 174	El Riego	L12-5	Ibid.:95, 96
(9) I-574, I-675	5625 ± 195	El Riego	L12-6	Ibid.:90, 92
(10) I-651, I-668	4787 ± 134	El Riego	L12-7	Ibid.:90, 91
(11) GX-783	7840 ± 240	Guilá Naquitz	K10-1	Flannery corres., 1967
(12) GX-873	7280 ± 120	Guilá Naquitz	K10-2	Ibid.
(13) GX-784	6910 ± 180	Guilá Naquitz	K10-3	Ibid.
(14) GX-872	5545 ± 90	Guilá Naquitz	K10-4	Ibid.
(15) M-980	6780 ± 400	Early Santa Marta	I18-1	*Radiocarbon* 3:120
(16) M-979	5370 ± 300	Late Santa Marta	I17-2	Ibid.
(17) M-500	6590 ± 450	Infiernillo	O8-1	*Science* 127:1103
(18) M-498	6250 ± 450	Infiernillo	O8-2	Ibid.
		Coxcatlan Phase		
(19) I-457	5050 ± 220	Coxcatlan	L11-8	*Radiocarbon* 11:89
(20) I-761	4400 ± 230	Coxcatlan	L11-9	Ibid.:94
(21) I-573	4150 ± 200	Coxcatlan	L11-10	Ibid.:96
(22) I-459, I-664, I-567, M-1089	4121 ± 96	Coxcatlan	L11-11	Ibid., 11:89, 91; 4:200
(23) I-768, I-754	3897 ± 197	Coxcatlan	L11-12	Ibid., 11:94, 95
(24) GX-782	3295 ± 105	Coxcatlan (Cueva Blanca)	K9-5	Flannery corres., 1967
(25) M-502	3280 ± 350	Ocampo	O7-3	*Science* 127:1104
(26) Tx-235	3000 ± 160	Cueva de la Zona, Layer 3	P3-1	*Radiocarbon* 8:465
(27) Tx-150	2890 ± 220	Cueva de la Zona, Layer 21-22	P3-2	Ibid., 7:312
(28) Tx-237	2805 ± 110	Cueva de la Zona, Layer 2	P3-3	Ibid., 8:465
(29) Tx-236	2750 ± 120	Cueva de la Zona, Layer 1	P3-4	Ibid.
		Abejas Phase		
(30) I-569	3300 ± 250	Abejas	L10-13	*Radiocarbon* 11:96
(31) I-654	3075 ± 180	Abejas	L10-14	Ibid.:90
(32) I-766, I-594, I-652	3183 ± 112	Abejas	L10-15	Ibid.:90, 92
(33) I-593, I-653	3010 ± 140	Abejas	L10-16	Ibid.:90
(34) I-755, I-572	2750 ± 136	Abejas	L10-17	Ibid.:93, 94
(35) C-954	1995 ± 334	Flacco	O6-4	Chicago unpublished
(36) C-687	2495 ± 280	La Perra	N6-2	Libby 1955:130

(Table continued on following pages)

* Numbers in parentheses are for text reference.

NOTE: The references to *Radiocarbon* are to the publication issued annually by the American Journal of Science, New Haven. It seemed pedantic to quote authors of the many published date lists. Dates published in other journals are listed by volume and page of the journal.

(Table 9, continued)

Date No.	Date	Complex	Key	Reference
Purron Phase				
(37) I-757, I-762	1925 ± 131	Purron	L9-18	*Radiocarbon* 11:94, 95
(38) I-753, I-670, I-666, I-570	1531 ± 91	Purron	L9-19	Ibid.:93, 94
(39) H-1263	2950 ± 130	Puerto Marquez, Level 38, Preceramic	B4-1	Brush 1965: 194, corres., 1964
(40) H-1258	2450 ± 140	Puerto Marquez, Level 33, Pox Pottery	B3-2	Ibid.
(41) H-1264	2250 ± 135	Puerto Marquez, Level 35, Preceramic	B2-3	Brush corres., 1964
Early Ajalpan Subphase				
(42) I-929	1270 ± 130	Early Ajalpan	L8-20	*Radiocarbon* 11:98
(43) I-934	1150 ± 140	Early Ajalpan	L8-21	Ibid.
(44) I-901, I-895	1218 ± 108	Early Ajalpan	L8-22	Ibid.:97
(45) M-978	1330 ± 200	Cotorra	I16-3	Ibid., 3:120
Late Ajalpan Subphase				
(46) I-566	1025 ± 200	Late Ajalpan	L7-23	*Radiocarbon* 11:96
(47) I-923, I-935	972 ± 92	Late Ajalpan	L7-24	Ibid.:97, 98
(48) I-924, I-927, I-752	980 ± 157	Late Ajalpan	L7-25	Ibid.
(49) I-767	900 ± 190	Late Ajalpan	L7-26	Ibid.:97
(50) I-916, I-914, I-908	708 ± 71	Late Ajalpan	L7-27	Ibid.:99, 100
(51) I-931, I-915	803 ± 89	Late Ajalpan	L7-28	Ibid.:100, 101
(52) Y-1150	978 ± 105	Cuadros	A9-1	Ibid., 5:333
(53) Y-1154	928 ± 105	Cuadros	A9-2	Ibid.
(54) Y-1166	814 ± 90	Cuadros	A9-3	Ibid.
(55) Y-1151	765 ± 105	Cuadros	A9-4	Ibid.
(56) Y-1798	1150 ± 140	San Lorenzo	J8-1	Coe, Diehl, and Stuiver 1967
(57) Y-1801	1140 ± 80	San Lorenzo	J8-2	Ibid.
(58) Y-1800	1100 ± 100	San Lorenzo	J8-3	Ibid.
(59) Y-1797	1060 ± 80	San Lorenzo	J8-4	Ibid.
(60) Y-1802	920 ± 140	San Lorenzo	J8-5	Ibid.
(61) UCLA-1267B	980 ± 80	San Lorenzo	J8-5a	Heizer et al. 1967: 14
(62) GX-785	975 ± 85	San José	K7-6	Flannery corres., 1967
(63) GX-875	930 ± 95	San José	K7-7	Ibid.
(64) GrN-774	1060 ± 150	Chiapa de Corzo (Cotorra)	I15-4	*Radiocarbon* 6:363
(65) M-661	990 ± 250	Iglesia	M17-1	*Science* 128:1120
Early Santa Maria Subphase				
(66) I-896, I-928, I-900, I-909	766 ± 68	Early Santa Maria	L6-29	*Radiocarbon* 11:98, 99, 100, 101
(67) I-903, I-904, I-925	842 ± 75	Early Santa Maria	L6-30	Ibid.:99
(68) I-910, I-919	775 ± 92	Early Santa Maria	L6-31	Ibid.:100
(69) I-922, I-913, I-906	765 ± 77	Early Santa Maria	L6-32	Ibid.:99, 100, 101
(70) I-911	635 ± 130	Early Santa Maria	L6-33	Ibid.:102
(71) I-893, I-917	608 ± 87	Early Santa Maria	L6-34	Ibid.:101, 102
(72) I-899, I-902	775 ± 106	Early Santa Maria	L6-35	Ibid.
(73) I-898, I-905	718 ± 99	Early Santa Maria	L6-36	Ibid.:99
(74) SI-124	800 ± 60	Early Santa Maria	L6-37	Ibid., 7:250
(75) I-933	635 ± 130	Early Santa Maria	L6-38	Ibid., 11:101
(76) I-894, I-907	608 ± 92	Early Santa Maria	L6-39	Ibid.:98, 99
(77) M-535	1160 ± 300	La Venta	J7-6	*Science* 127:1104
(78) UCLA-902	990 ± 80	La Venta	J7-7	*Radiocarbon* 7:345
(79) M-529	910 ± 300	La Venta	J7-8	*Science* 127:1104
(80) M-530	810 ± 300	La Venta	J7-9	Ibid.
(81) UCLA-1284A	580 ± 60	La Venta	J7-10	*Radiocarbon* 10:150
(82) UCLA-1284B	600 ± 60	La Venta	J7-11	Ibid.
(83) UCLA-788B	700 ± 240	La Venta	J7-12	Ibid., 8:474

(Table 9, continued)

Date No.	Date	Complex	Key	Reference
(84) M-532	700 ± 300	La Venta	J7-13	*Science* 127:1104
(85) UCLA-1285	870 ± 60	La Venta	J7-14	*Radiocarbon* 10:151
(86) L-427	780 ± 150	Dili	I14-5	Ibid., 1:22
(87) Gro-1172	928 ± 60	Dili	I14-6	Dixon 1959: 41
(88) GX-172	745 ± 185	Xe	F9-1	*Radiocarbon* 7:51
(89) GrN-1524	560 ± 45	Francesca	I12-6	Ibid., 6:364
(90) GrN-1056	429 ± 60	Francesca	I12-7	Ibid., 6:363
(91) P-750	588 ± 53	Eb	H11-1	Ibid., 8:374
(92) P-759	456 ± 47	Tzec	H10-2	Ibid., 8:376
(93) Y-1167	790 ± 70	Conchas 1	A7-5	Ibid., 5:333
(94) GX-134	510 ± 130	Conchas 2	A6-6	Ibid., 8:155; Parsons 1967: 45-48
(95) Y-1629	810 ± 160	Iglesia	M17-2	Tolstoy and Guenette 1965: 91
(96) M-660	575 ± 250	Totolica	M16-3	*Science* 128:1120
(97) Y-1627	710 ± 50	Totolica	M16-4	Tolstoy and Guenette 1965: 91
(98) M-662	500 ± 250	Middle Zacatenco	M15-9	*Science* 128:1120
(99) UCLA-595	540 ± 60	Middle Zacatenco	M15-10	*Radiocarbon* 6:332
(100) UCLA-594	610 ± 80	Middle Zacatenco	M15-11	Ibid.
(101) UCLA-596	610 ± 100	Middle Zacatenco	M15-12	Ibid., 6:333
Late Santa Maria Subphase				
(102) I-918	45 ± 100	Late Santa Maria	L5-41	*Radiocarbon* 11:100
(103) I-568, I-575	445 ± 101	Late Santa Maria	L5-40	Ibid.: 93
(104) Y-1626	410 ± 120	Atoto (Ticoman I)	M14-8	Tolstoy and Guenette 1965: 91
(105) C-200	472 ± 250	Atoto (Ticoman I)	M14-6	Libby 1955: 192
(106) UCLA-207	650 ± 70	Atoto (Ticoman I)	M15-7	*Radiocarbon* 5:12
(107) Y-1628	480 ± 60	Atoto (Ticoman I)	M15-5	Tolstoy and Guenette 1965: 91
(108) UCLA-603, UCLA-209	315 ± 53	Ticoman II	M14-9	*Radiocarbon* 5:12; 6:333
(109) UCLA-208, UCLA-602	195 ± 39	Ticoman III	M12-10	Ibid.
(110) C-424	650 ± 170	Monte Alban I	K5-8	Libby 1955: 130
(111) (unnumbered)	390 ± 275	Monte Alban I	K5-9	Bernal 1965: 799
(112) C-425	273 ± 145	Monte Alban II	K4-10	Libby 1955: 130
(113) GrN-2301	250 ± 70	Monte Alban II	K4-11	*Radiocarbon* 6:364
(114) I-2678	40 ± 110	Monte Alban II	K4-12	Paddock corres., 1967
(115) M-528	450 ± 250	Tres Zapotes	J6-15	*Science* 127:1104
(116) UCLA-1283	430 ± 60	Tres Zapotes	J6-16	Ibid.
(117) M-533, UCLA-903, UCLA-1287	180 ± 300	Tres Zapotes	J6-17	Ibid.
(118) GrN-1525	220 ± 50	Guanacaste	I11-8	*Radiocarbon* 6:364
(119) GrN-1589	A.D. 30 ± 45	Horcones	I10-9	Ibid.
(120) GrN-1932	40 ± 65	Horcones	I10-10	Ibid.
(121) GX-162	245 ± 164	San Felix	F8-2	Ibid., 7:49
(122) GX-163	880 ± 130	San Felix	F8-3	Ibid.:50
(123) GX-164	295 ± 120	San Felix	F8-4	Ibid.
(124) P-563	267 ± 63	Cauac, Tikal	H8-3	Ibid., 8:379
(125) P-560	125 ± 49	Cauac, Tikal	H8-4	Ibid.:378
(126) P-535	A.D. 16 ± 63	Cauac, Tikal	H8-18	Ibid.
(127) P-562	A.D. 76 ± 54	Cauac, Tikal	H8-16	Ibid.
(128) P-757	A.D. 20 ± 51	Chuen, Tikal	H9-14	Ibid., 8:377
(129) P-754	67 ± 52	Chuen, Tikal	H9-13	Ibid.
(130) P-753	118 ± 52	Chuen, Tikal	H9-15	Ibid., 8:376
(131) P-756	114 ± 52	Chuen, Tikal	H9-11	Ibid.:377
(132) P-755	275 ± 55	Chuen, Tikal	H9-6	Ibid.
(133) P-751	219 ± 52	Chuen, Tikal	H9-7	Ibid., 8:376
(134) P-758	90 ± 53	Chuen, Tikal	H9-12	Ibid.:377
(135) P-752	207 ± 52	Chuen, Tikal	H9-8	Ibid.:376
(136) Y-384	390 ± 50	Las Charcas	C8-1	Ibid., 1:162
(137) M-1257	330 ± 130	Las Charcas	C8-2	Ibid., 6:15
(138) Y-390	385 ± 50	Majadas	C8-3	Ibid., 1:163

(Table 9, continued)

Date No.	Date	Complex	Key	Reference
(139) Y-401	290 ± 60	Arevalo	C9-4	Ibid.:162
(140) Y-402	120 ± 50	Arevalo	C9-5	Ibid.
(141) Y-391	75 ± 60	Santa Clara, Arenal, Miraflores	C6-6	Ibid.
Early Palo Blanco Subphase				
(142) I-656	A.D. 180 ± 100	Early Palo Blanco	L4-42	*Radiocarbon* 11:91
(143) I-921	A.D. 5 ± 200	Early Palo Blanco	L4-42a	Ibid.:93
(144) UCLA-206	A.D. 1 ± 80	Patlachique	M11-11	Ibid., 5:12
(145) M-663	90 ± 200	Patlachique	M11-12	*Science* 128:1120
(146) UCLA-205	A.D. 160 ± 75	Tzacualli	M10-13	*Radiocarbon* 5:12
(147) Y-664	A.D. 20 ± 80	Tzacualli	M10-14	Ibid., 2:57
(148) M-1118	A.D. 145 ± 120	Tzacualli	M10-15	Ibid., 6:13
(149) St-162	A.D. 230 ± 65	Tlamimilolpa	M8-16	*Science* 126:496
(150) GrN-1916	A.D. 105 ± 50	Istmo	I9-11	*Radiocarbon* 5:364
(151) M-977	A.D. 80 ± 200	Istmo (Piedra Parada)	I9-12	Ibid., 3:120
(152) Y-367	A.D. 170 ± 60	Tzakol I, II, III	G4-1	Ibid., 1:164
(153) P-565	A.D. 24 ± 48	Cimi	H7-16	Ibid., 8:379
(154) P-768	A.D. 173 ± 45	Cimi	H7-17	Ibid.
(155) P-575	A.D. 201 ± 59	Muluk	H6-18	Ibid., 8:382
(156) Y-378	A.D. 165 ± 60	Esperanza Aurora	C5-8	Ibid., 1:162
(157) Y-396	A.D. 90 ± 60	Esperanza Aurora	C5-7	Ibid.
(158) Y-406	A.D. 150 ± 60	Santa Clara, Arenal, Miraflores	C6-9	Ibid.
Late Palo Blanco Subphase				
(159) I-671, I-673	A.D. 187 ± 96	Late Palo Blanco	L3-43	*Radiocarbon* 11:92
(160) I-657	A.D. 300 ± 130	Late Palo Blanco	L3-44	Ibid.:96
(161) I-663	A.D. 325 ± 150	Late Palo Blanco	L3-45	Ibid.:91
(162) UCLA-610	A.D. 200 ± 80	Xolalpan	M7-17	Ibid., 7:344
(163) UCLA-612	A.D. 200 ± 80	Xolalpan	M7-18	Ibid.
(164) Y-1266	A.D. 160 ± 80	Xolalpan	M7-19	Stuiver, pers. commun.
(165) UCLA-611	A.D. 250 ± 80	Xolalpan	M7-20	*Radiocarbon* 7:344
(166) UCLA-620	A.D. 290 ± 80	Xolalpan	M7-21	Ibid.:345
(167) UCLA-609	A.D. 150 ± 80	Xolalpan	M7-22	Ibid.:344
(168) UCLA-615	A.D. 170 ± 80	Xolalpan	M7-23	Ibid.
(169) UCLA-616	A.D. 200 ± 80	Xolalpan	M7-24	Ibid.
(170) UCLA-614	A.D. 370 ± 80	Xolalpan	M7-25	Ibid.
(171) Y-1265	A.D. 290 ± 80	Xolalpan	M7-26	Stuiver, pers. commun.
(172) Y-1264	A.D. 330 ± 80	Xolalpan	M7-27	Ibid.
(173) UCLA-613	A.D. 660 ± 80	Metepec	M6-28	*Radiocarbon* 7:344
(174) C-426	A.D. 298 ± 185	Monte Alban III	K3-13	Paddock corres., 1967
(175) I-2680	A.D. 540 ± 100	Monte Alban III	K3-14	Ibid.
(176) I-2679	A.D. 720 ± 100	Monte Alban III	K3-15	Ibid.
(177) P-571	A.D. 325 ± 60	Manik	H5-19	*Radiocarbon* 8:380
(178) P-281	A.D. 420 ± 50	Manik	H5-20	Ibid., 4:156
(179) P-284	A.D. 400 ± 58	Manik	H5-21	Ibid.
(180) P-294	A.D. 600 ± 52	Manik	H5-22	Ibid.
(181) P-295	A.D. 210 ± 50	Manik	H5-23	Ibid.
(182) P-296	A.D. 230 ± 50	Manik	H5-24	Ibid.
(183) P-570	A.D. 676 ± 50	Ik	H4-25	Ibid., 8:380
(184) av.10 dates Penna.	A.D. 746 ± 34	Ik	H4-26	Ibid., 4:153-154; Satterthwaite and Ralph 1960
(185) av. 5 dates Penna.	A.D. 684 ± 37	Ik	H4-27	Ibid.
(186) av. 5 dates UCLA	A.D. 625 ± 26	Ik	H4-28	*Radiocarbon* 5:14; UCLA 1958 series
(187) Y-368	A.D. 620 ± 70	Tepeu I	G3-2	*Radiocarbon* 1:165

(Table 9, continued)

Date No.	Date	Complex	Key	Reference
(188) LJ-531	A.D. 430 ± 200	Early Period, Phase I (Chakan)	E6-1	Ibid., 5:270
(189) M-857	A.D. 450 ± 200	Motul	E5-2	Ibid., 1:191
(190) W-707	A.D. 500 ± 200	Motul	E5-3	Ibid., 2:182
(191) Y-629	A.D. 390 ± 70	Esperanza, Aurora	C5-10	Ibid., 1:162
(192) Y-405	A.D. 290 ± 60	Esperanza, Aurora	C5-11	Ibid.
(193) GrN-1906	A.D. 350 ± 50	Esperanza, Aurora	C5-12	Ibid., 6:364
(194) GX-126	A.D. 260 ± 110	San Francisco	A4-7	Ibid., 8:154; Parsons 1967: 45-47
(195) GX-127	A.D. 390 ± 120	San Francisco	A4-8	Ibid.
(196) GX-124	A.D. 490 ± 120	San Francisco	A4-9	Ibid.
(197) TBN-315-1	A.D. 527 ± 136	San Francisco	A4-10	*Radiocarbon* 5:60; Parsons 1967: 45-47
(198) GX-123	A.D. 600 ± 120	San Francisco	A4-11	Ibid.
(199) M-1580	A.D. 650 ± 130	San Francisco	A4-12	*Radiocarbon* 8:282; Parsons 1967: 45-47
(200) H-1054	A.D. 600 ± 105	Eslabones	N3-4	Nicholson, pers. commun.
(201) H-1055	A.D. 1 ± 110	Eslabones	N3-3	Ibid.
(202) M-506	A.D. 230 ± 200	Palmillas	O3-5	Unlisted, MacNeish 1958: 194
		Early Venta Salada Subphase		
(203) I-659	A.D. 900 ± 110	Early Venta Salada	L2-46	*Radiocarbon,* 11:91
(204) I-672, I-674, I-662	A.D. 1100 ± 78	Early Venta Salada	L2-47	Ibid.:91, 92
(205) Y-369	A.D. 1180 ± 60	Tohil	D2-1	Ibid., 1:165
(206) SI-281	A.D. 840 ± 80	San Juan	A3-13	Ibid., 9:377
(207) M-1468	A.D. 1190 ± 100	Paredon	I5-14	Ibid., 7:143
(208) M-1469	A.D. 1080 ± 100	Paredon	I5-13	Ibid.
(209) M-1467	A.D. 1340 ± 100	Paredon	I5-15	Ibid.
(210) I-2679	A.D. 720 ± 100	Monte Alban III (IV)	K2-16	Paddock 1967
(211) M-1151	A.D. 890 ± 150	Monte Alban V (IV)	K2-17	*Radiocarbon* 5:245; 6:14
(212) Y-383	A.D. 770 ± 60	Pokom	D3-1	Ibid., 1:164
(213) Tx-114	A.D. 785 ± 75	Small Point Complex	P1-1	Ibid., 7:311
(214) Tx-204	A.D. 970 ± 130	Small Point Complex	P1-2	Ibid.
(215) Tx-205	A.D. 1105 ± 115	Small Point Complex	P1-3	Ibid.
		Late Venta Salada Subphase		
(216) M-1248	A.D. 1200 ± 100	Monte Alban V	K1-18	Ibid., 6:15
(217) M-1249	A.D. 1380 ± 100	Monte Alban V	K1-19	Ibid.
(218) M-1250	A.D. 1580 ± 100	Monte Alban V	K1-20	Ibid.

American Journal of Science, New Haven. The key numbers in Table 9 permit locating dates on Fig. 4 so that their positions relative to other dates and phases may be seen. The table also includes date numbers and references to the sample descriptions.

The Ajuereado Phase

The earliest archaeological phase in the Tehuacan sequence, Ajuereado, is defined by the artifacts found in five of the lowest zones in Coxcatlan Cave (Tc 50), Zones XXVIII to XXIII, and in one zone in El Riego Cave (Tc 35w), Zone 6. We have at times divided this phase into early and late subphases. The two subphases present rather different kinds of problems in dating. The earliest zone, XXVIII, included nothing but a few significant animal bones. Early Ajuereado includes as well Zones XXVII, XXVI, and XXV at Coxcatlan Cave, but the meager number of artifacts do not define the subphase well. The adequate sample of faunal remains, however, contained bones of extinct animals. Zone XXV had the best sample of artifacts, representing all the diagnostic traits for Ajuereado except Lerma points. The bones of extinct horse and antelope in Zones XXVIII to XXV are evidence that the climate

TABLE 10

A Partial List of Laboratory Numbers of Dates Rejected
(other than Tehuacan sequence)

C-196
C-198
C-199
C-203
C-204
C-205
C-207
C-421
C-422
C-687
C-884
C-886
C-887
C-948
C-949

GrN-790
GrN-1512
GrN-1637
GrN-1638
GrN-1916
GrN-2301

Gro-452
Gro-1166

GX-165
GX-166
GX-167
GX-168
GX-169
GX-170
GX-171
GX-208

Hv-362

I(NGS)-171

L-286A
L-357
L-561

LJ-87
LJ-272
LJ-273
LJ-279
LJ-331
LJ-505
LJ-508
LJ-531
LJ-975
LJ-976

M-184
M-185
M-186
M-187
M-188
M-189
M-190
M-191
M-193
M-430
M-431
M-432
M-497
M-501
M-503
M-504
M-505
M-534
M-536
M-567
M-568
M-592
M-593
M-611
M-612
M-613
M-663
M-664
M-665
M-719A
M-719B
M-774
M-857
M-861
M-1123
M-1124
M-1125
M-1164
M-1165
M-1166
M-1251
M-1253
M-1283
M-1467
M-1468
M-1469

P-285
P-409
P-561
P-562
P-570
P-575
P-748
P-749

TBN-310-1
TBN-310-2
TBN-310-3
TBN-313-I
TBN-313-II
TBN-315-1
TBN-315-2

Tx-50
Tx-51
Tx-101
Tx-145
Tx-146
Tx-147
Tx-148
Tx-149
Tx-205
Tx-206
Tx-207
Tx-208
Tx-209

UCLA-145
UCLA-207
UCLA-210
UCLA-211
UCLA-212
UCLA-228
UCLA-597
UCLA-598
UCLA-599
UCLA-600
UCLA-601
UCLA-609
UCLA-618
UCLA-621
UCLA-788c
UCLA-788d
UCLA-902
UCLA-903
UCLA-909
UCLA-1218B
UCLA-1253
UCLA-1267A
UCLA-1280A
UCLA-1280B
UCLA-1286
UCLA-1287

W-479
W-480
W-488
W-493
W-707
W-836
W-837

Y-292
Y-369
Y-370
Y-374
Y-377
Y-382
Y-392
Y-393
Y-437
Y-626
Y-626 bis.
Y-627
Y-1799

NOTE: Table 10 lists many of the dates from Mesoamerica which have been rejected for this study. The list is not quite complete for record of some dates not used was not made during the complex process of screening. A large proportion of these dates were rejected because the record of the samples indicated the possibility of error in assignment to a particular phase. Another group of dates were eliminated because they were out of line with the order established. These are worrisome because, despite the weight of the evidence, the established order may be wrong. We believe, however, that the chances for this are small. A third group of dates have not been used because they duplicate the chronological record and addition to the tables serves no useful purpose. The table was begun about 1964 and additions have been made up to the end of 1967. Where possible some adjustments were made during 1968, but essentially the table represents opinions as of 1966-1967.

differed from that of the present time. Because evidence of extinct animals and a cooler climate were not found above this level we believe Zone XXV marks a period of extinction of certain fauna and a time of climatic change. Flannery, in volume 1, says that the deposits of Zones XXV and earlier must antedate 7600 B.C. and the character of the fauna indicates that the deposits especially in Zone XXVIII could be as early as 10,000 B.C.

At the sites in the Valsequillo area in Puebla, about fifty miles from the Tehuacan Valley, artifacts and extinct forms of horse and other animals were found in the upper layers of the Hueyatlaco site called San Baltasar in volume 2 of this series. These are very similar and presumably closely related to early Ajuereado artifacts and fauna. Malde and Irwin-Williams (1967) date the materials on the basis of correlations of deposits with deposits in the Barranca de Caulipan from which there were several radiocarbon dates. Shells from the locus of a flake scraper are dated 19,900±500 B.C. (W-1896). The presumption that the date is actually the date of the scraper and the correlation of the deposits which implies that the artifacts at Hueyatlaco are of comparable age is based upon stratigraphic correlations which have not been well demonstrated.

The remains of a mammoth at Iztapan in the Valley of Mexico are dated 7300±250 B.C. (Table 9, no. 1). Also from the Valley of Mexico, at San Bartolo Atepehuacan, mammoth remains with an associated flint chip have been dated 7720±400 B.C. (Table 9, no. 2). Other dates have been determined from samples on sites near Tlapacoya. These dates are in the general vicinity of 20,000 B.C. They refer to geological situations as well as cultural materials that as yet cannot be identified as being comparable to Ajuereado types of artifacts. The associations and significance of the data are not yet clear; the field work and analysis continues.

The Lerma phase of Tamaulipas includes an artifact complex very much like late Ajuereado but extinct animals are not associated with it. A date on the phase is 7320±500 B.C. (Table 9, no. 3). The earliest dates from the Frightful Cave in Coahuila are 7590±550 B.C. (M-192a) and 7350±400 B.C. (M-192b). The dated levels have modern rather than extinct fauna, but unfortunately the cultural context is very ambivalent and the stratigraphy and other dates described are extremely confusing — in fact downright frightful (Taylor 1956).

In volume 2 we suggested that there was a relationship between the stone artifacts from Ajuereado and Hueyatlaco (San Baltasar) in the Valsequillo basin near Puebla, the Iztapan site in the Valley of Mexico, the lower levels of San Nicolas Cave in Queretaro and the Lerma phase of the Sierra de Tamaulipas. Unfortunately there are useful radiocarbon dates only for Lerma and Iztápan. Lerma and late Ajuereado have in common domed scraping planes, ovoid end-scrapers, crude end-scrapers, gravers, blocky-core choppers, Lerma points, thick side-scrapers, and pebble hammers. Iztápan and late Ajuereado have in common blades and possible burins or gravers, plano-convex and keeled end-scrapers, Lerma points, flake and blocky-core choppers.

In summary, there is considerable evidence that the Pleistocene fauna in Mexico was extinct before 7000 B.C. and perhaps before 7600 B.C. Early Ajuereado began when the presently extinct animals were in existence but the date of this early occupation is impossible to determine from the evidence now in hand. We anticipate that dating derived from investigations at Valsequillo, Tlapacoya, and, we hope, sites yet to be found, will eventually provide relevant chronological information.

Late Ajuereado probably began during the period when the animals were becoming extinct. Cultural similarities suggest that the subphase has features in common with Lerma and even Iztápan and other sites. An arrangement of the dates and consideration of the characteristics and dating of the following El Riego phase leads to an estimate that Ajuereado ended about 6800 B.C.

The El Riego Phase

The El Riego phase is identified in twenty-one zones distributed among eight sites. The stratigraphy of the zones in the sites is clear and from the content of the zones the sequence can be inferred with some confidence. Seven dates from nine zones in five sites are in very satisfactory order (Table 9, nos. 4-10; Fig. 4), and form the basis for the estimate that the phase commenced about 6800 B.C. and ended at approximately 5000 B.C.

We have fixed upon 6800 B.C. as the estimated date for the beginning of El Riego largely because of a marked change in the quantity of artifacts found and the number of types present in Zone XXII of Coxcatlan Cave. The estimate is useful even though there is some evidence that it may be a few hundred years too late. The dates on many "early" zones in the valley appear to be consistently too late. However, the main reason for indicating uncertainty is found in dates for levels in Guilá Naquitz Cave near Mitla, Oaxaca. These are 7840±240 B.C., 7280±120 B.C., 6910±180 B.C., 5545±90 B.C., (Table 9, nos. 11-14). The artifact complex is imperfectly known at this writing, but it is associated with modern fauna and resembles, at least in part, El Riego materials and also materials from Santa Marta, upon which we shall comment below.

The estimated end date for El Riego, which also marks the beginning of the Coxcatlan phase, is located midway between the dates for Zone XV and Zone XIII. Zones XV and XIV include comparable quantities and types of artifacts, but Zone XIII has a slightly different content (Table 1), suggesting a change in the habits of the people and thus marking the beginning of a new phase.

Components related to El Riego are Santa Marta in Chiapas, Guilá Naquitz Cave in southern Oaxaca, Tetela Cave in northern Puebla, the Hidalgo complex from Tecalote Cave in Hidalgo, and Infiernillo of southwestern Tamaulipas. In volume 2, we have classified these components, including El Riego, as part of the Desert Tradition; for they have a number of generalized traits in common. These include plant collecting combined with a seminomadic way of life, and artifacts such as crude blades, contracting-stemmed points, leaf-shaped points, scraper-planes, choppers, millingstones and mullers, mortars and pestles, and possibly gouges.

Santa Marta Cave in Chiapas produced traits which are closely related to El Riego; namely, domed and flat-topped scraper-planes, crude ovoid plano-convex end-scrapers, gouges, end-of-blade scrapers; thick and thin side-scrapers; spokeshaves; a wide variety of choppers, pebble mullers and manos, boulder milling stones and metates, pebble hammers, split-bone awls, and Nogales, Abasolo, San Nicolas, Tortugas, and Trinidad points. Two radiocarbon dates, 6780±400 B.C. and 5370±300 B.C. (Table 9, nos. 15, 16), are in agreement with the radiocarbon dates from the Tehuacan Valley.

In Guilá Naquitz Cave in Oaxaca, Flannery has uncovered a new complex which is described as being closely related to Santa Marta, the dates for which are quoted above. A brief look at these materials lead to the impression that there are some close resemblances to El Riego phase materials but perhaps the Santa Marta artifacts are even more similar. We must await more excavation and precise description before we can establish the degree of similarity between any of them. Nevertheless, although the dates for Guilá Naquitz are a little earlier, they are generally of the same order as the dates for the El Riego phase.

The Infiernillo complex is well defined by materials from clearly identified floor levels in caves in southwestern Tamaulipas. Comparison of projectile-point types show some significant correspondences. Point types found both in El Riego and Infiernillo are Trinidad, Hidalgo, San Nicolas, and Abasolo. El Riego and Tilapa points do not appear in Tamaulipas in this period, and Infiernillo points, present in Tamaulipas, are not found in El Riego. Almagre points found in Infiernillo do not appear in the Tehuacan Valley until Coxcatlan times. El Riego, Nogales, and Flacco points common to the El Riego phase do not appear in Tamaulipas until much later. The two complexes also have in common flat-topped, domed, and multi-faceted scraper planes, gouges, crude plano-convex and keeled end-scrapers and a number of more general type scrapers, blocky-core choppers, slab flakers and ellipsoidal choppers, ovoid bifaces, hammer stones, boulder milling stones or metates, possible cylindrical pestles, split-bone awls, and twined blankets. The subsistence and settlement patterns of El Riego and Infiernillo are also similar in a general way. Infiernillo is dated by two radiocarbon dates: 6590 ± 450 B.C. and 6250 ± 450 B.C. (Table 9, nos. 17, 18).

In sum, dates on deposits from other regions which are correlative with El Riego in large measure confirm the estimates made for the age of this phase in the Tehuacan Valley. There are suggestions in the total list, however, that the phase may have begun earlier in some regions and lasted longer in others.

The Coxcatlan Phase

The Coxcatlan phase in the Tehuacan Valley is represented by ten excavated components, the dates on five of which lead to an estimate that the phase was in existence from about 5000 B.C. to 3400 B.C. (Table 9, nos. 19-23; Fig. 4).

Phases that appear to be closely related to Coxcatlan owing to the presence of comparable artifacts include the lowest level of Cueva Blanca near Mitla in Oaxaca, the middle levels of Tetela Cave in northern Puebla, and the Tecalote phase remains from Tecalote Cave in Hidalgo. The traits held in common are various crude and fine blades, gouges, stone bowls, and Tilapa, Coxcatlan, and Garyito points, and perhaps as well a type of subsistence which includes a variety of incipient agriculture. The level at Cueva Blanca is the only one having a radiocarbon date, 3295 ± 105 B.C. (Table 9, no. 24). The relationship between the several levels mentioned and Coxcatlan phase levels in the Tehuacan Valley is very close, for all contain Coxcatlan points and most of the traits mentioned above. Most of the artifact inventories show a large proportion of Garyito points, a common characteristic in the Tehuacan sequence of

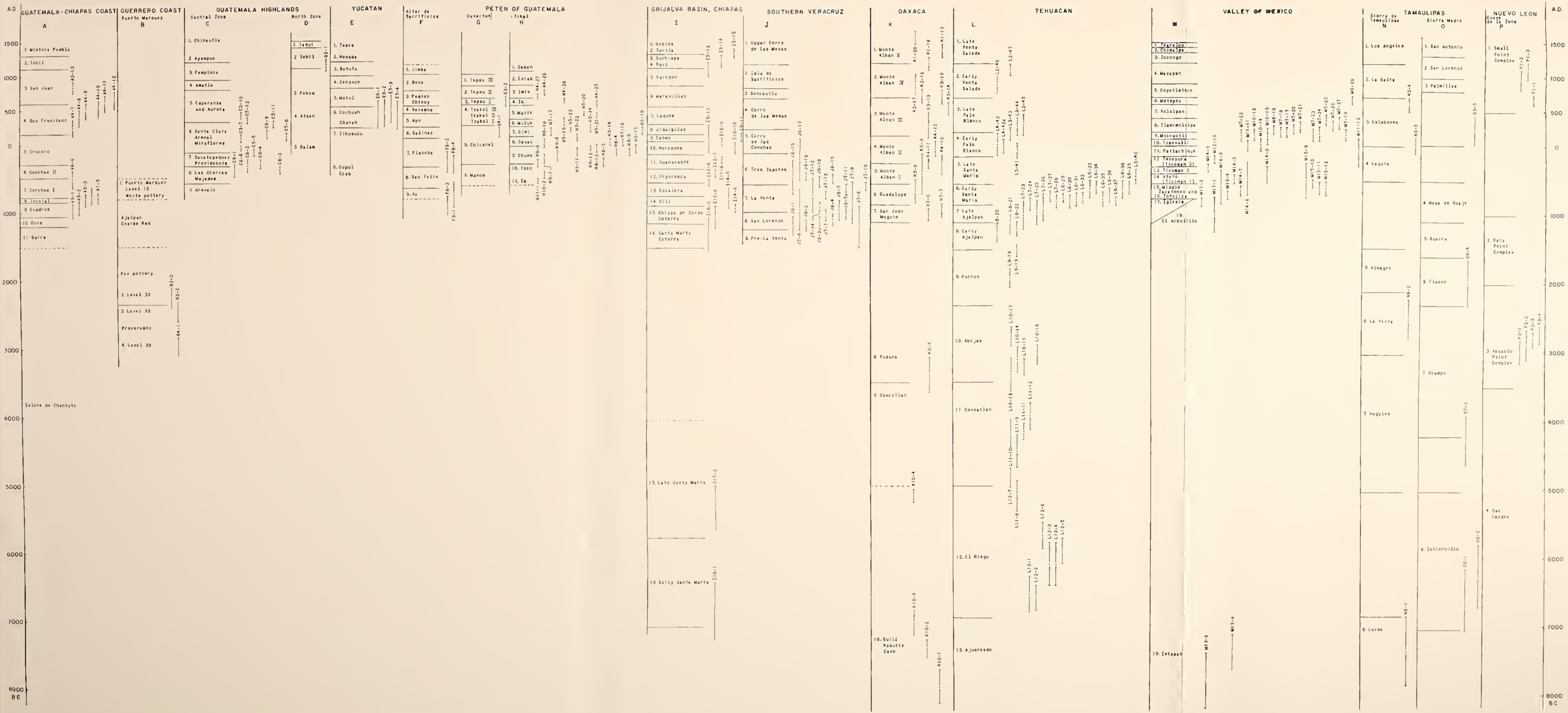


Fig. 4. Mesoamerican regional sequences and accepted radiocarbon dates. (Letter and number designations refer to Table 9.)

both the very end of the Coxcatlan phase and particularly the following Abejas phase. The latest date for the Coxcatlan phase, from Zone Q^1 of Purron Cave, is 3897 ± 197 B.C. (Table 9, no. 23). The next date in the sequence is from Cueva Blanca and is some 600 years later. Incomplete data indicate some relationship between the early level in Cueva Blanca and late Coxcatlan; there may have been a slow transition from the Coxcatlan to the Abejas phase. At least one component in the Tehuacan sequence and perhaps more intervene between the components from which the two dates originated. We therefore postulate a midpoint between the dates and estimate that the Coxcatlan phase ended about 3400 B.C.

As we pointed out in volume 2, there are complexes in northern Mexico which, even though they are contemporaneous, appear to be the expression of a different tradition. These phases are: Ocampo in southwest Tamaulipas, 3280 ± 350 B.C. (Table 9, no. 25); Nogales in the Sierra de Tamaulipas and northern Tamaulipas; and the earliest remains from Epstein's Cueva de la Zona in Nuevo Leon, 3000 ± 160 B.C., 2890 ± 220 B.C., 2805 ± 110 B.C., 2750 ± 120 B.C. (Table 9, nos. 26-29). We also suspect that the ill-defined and badly confused middle levels of the Coahuila complex from Frightful Cave, Coahuila, are of this general time period and belong to the northern Mexican complexes called Repelo and Pecos River (MacNeish, Nelken-Terner, and Johnson 1967:244). Although the radiocarbon dates indicate that the phases listed are contemporaneous with Coxcatlan, lack of traits in common with Coxcatlan suggests that different trends of developments prevailed in the north. This lack renders them useless for specific comparison with the Tehuacan sequence.

The Abejas Phase

Dates from five zones in the Tehuacan Valley are the basis for an estimate that the transition between the Coxcatlan phase and Abejas phase was effected about 3400 B.C., and that Abejas ended about 2300 B.C. (Table 9, nos. 30-34; Fig. 4). We have commented upon the development of the estimated date for the beginning of this phase. The date of the end of the phase is indeed a rough estimate. The mean of the latest date in the Tehuacan sequence is 625 years earlier than the mean of the earliest date on zones producing Pox pottery on the Guererro coast, which is correlated with the early part of the Purron phase (Table 9, nos. 40, 41). The date 2300 B.C. falls between the two dates on Pox pottery and may indicate very roughly the date of the beginning of pottery in Mesoamerica.

The remains from the upper levels at Tetela Cave in northern Puebla and other complexes such as San Nicolas from Queretaro are related to Abejas, but there are no radiocarbon dates from these levels. It does appear that the dates on Abejas levels from Tehuacan are satisfactory and that they are an indication of the age of the levels at Tetela Cave and the San Nicolas complex.

Materials from the preceramic Flacco and La Perra phases in Tamaulipas suggest a distant relationship with Abejas. The dates 1995 ± 334 B.C. (Table 9, no. 35) on Flacco and 2495 ± 280 B.C. (Table 9, no. 36) on La Perra indicate contemporaneity.

The Purrón Phase

Purron phase materials are ill-defined in the Tehuacan Valley, and they, or related remains, are difficult to find in other regions in Mexico. The two levels at Purron Cave including this phase have produced the following dates: Zone K, 1925 ± 131 B.C.; Zone K^1, 1531 ± 91 B.C. (Table 9, nos. 37, 38). Charles F. Brush (1965), in excavations at Puerto Marquez near Acapulco in Guerrero, found pottery which is identical to Purron Coarse and Purron Plain, types which appeared in Zone K of Purron Cave. A carbon sample from level 33 of the Puerto Marquez site, from which the first pottery came, has a date of 2450 ± 140 B.C. (Table 9, no. 40) and a sample from Level 35, which was preceramic, was dated 2250 ± 135 B.C. (Table 9, no. 41). A date on Layer 38, also preceramic, was 2950 ± 130 B.C. (Table 9, no. 39). The one sigma ranges of the first two dates overlap, and the stratigraphic situation permits the choice of 2300 B.C. as the general date for the Pox pottery. This agrees with our estimates for the beginnings of Purron pottery, which is the earliest pottery in the Tehuacan Valley. Before we can present exact dates for the Purron phase, however, and for all the early ceramics of this type, we obviously need not only more materials and information from additional sites in the Tehuacan Valley, but also more related pottery from other regions. The end date for the Purron phase, 1500 B.C., is based on radiocarbon dates for Tc 272, Zone K^1, and the beginning dates for the earliest Ajalpan levels.

The Early Ajalpan Subphase

There is more knowledge of the early Ajalpan subphase than there is of Purron, but comparative material from other parts of Mexico is largely lacking. The early Ajalpan sequence is documented by more than 16,000 artifacts, mainly potsherds, from five stratified sites. Radiocarbon dates for the three zones of Ts 204 are: Zone H, 1270 ± 130 B.C.; Zone G, 1150 ± 140 B.C.; Zone G^1, 1218±108 B.C. (Table 9, nos. 42-44). The dates on the fifth site, Zone J of Purron Cave, pointed out on page 26 above, were not satisfactory. Having in mind that the rather firm date for the latest component of the Purron phase is 1531 ± 91 B.C. (Table 9, no. 38), we estimate that the beginning of the Ajalpan phase should date between 1500 B.C. and 1270 B.C., the latter being the earliest Ajalpan date. Consideration of the comparative material leads to an opinion that materials associated with Ajalpan may be proved to be earlier in other parts of the region, and so we choose 1500 B.C. as a beginning date for Ajalpan.

Four cultural complexes appear to be directly related to early Ajalpan. At Puerto Marquez, Levels 31 and 32 include as dominant pottery types Ajalpan Coarse, Ajalpan Plain, and Ajalpan Coarse Red (Brush, pers. commun.). There are no radiocarbon dates for these levels but the Tehuacan dates indicate that they should fall between 1150 and 1500 B.C. A close relationship between the early ceramics of Chiapas and the Tehuacan Valley is indicated by the presence of wares similar to Ajalpan Plain and Ajalpan Coarse in Santa Marta Cave (MacNeish and Peterson 1962). In the Ajalpan site itself the dated Zones G and G^1 attributed to the early Ajalpan subphase included sherds resembling Mapache Red-rimmed ware, a type very common in the Cotorra phase which is found in the earliest ceramic levels in Santa Marta Cave. This latter phase has a radiocarbon date of 1330 ± 200 B.C. (Table 9, no. 45), which overlaps the early Ajalpan date and helps confirm it. Early Ajalpan levels in the Tehuacan Valley contain sherds of Coton Grooved Red which is diagnostic of the Barra phase of the Guatemala-Chiapas Coast (Green and Lowe 1967). This is evidence that Barra and early Ajalpan are coeval, dating between 1200 and 1500 B.C. In an early level at Santa Marta Cave, Level 5, there were five tecomate sherds with red rims and grooved bodies that may be Coton Grooved Red. If this identification is correct, it confirms the contemporaneity of early Ajalpan with Barra and Santa Marta-Cotorra phases.

In 1964 Robert Squier, excavating at the La Venta site, found a series of deposits underneath the ruins of the buildings. In his Cut C, at depths from 285 cm. to 365 cm., he found that Ajalpan Plain and Ajalpan Coarse Red were dominant types in the ceramic assemblage. Also in common with early Ajalpan of the Tehuacan Valley were sherds resembling Mapache Red-rimmed and, apparently, large, Hollow Dwarf figurines. One figurine fragment showed the distinctive scrolled incision of the ear found on the early Ajalpan solid Projecting-eye figurines. Unfortunately neither of Squier's dates are of assistance in establishing contemporaneity of the Pre-La Venta material and the early Ajalpan phase. The date 7800 ± 160 B.C. (UCLA-788d) is obviously not a date on a sample contemporaneous with ceramic remains. Furthermore, the date 1800 ± 80 B.C. (UCLA-788c) does not agree with our early Ajalpan dates (Berger and Libby 1966: 475). We reject these dates as not being useful for present purposes because the samples were not taken from fireplaces or clearly identifiable loci but were specks of charcoal collected from the fill of pits and could easily have been intrusive fragments or other increments which were not contemporaneous with sherds. In fact, we date Pre-La Venta remains in the period 1200 to 1500 B.C., using as a basis dates on comparative data from the Tehuacan Valley and from the San Lorenzo phase of southern Veracruz (Coe, Diehl, and Stuiver 1967).

Extending the scope of this comparison, we note that Squier found in his earlier levels, along with the early Ajalpan pottery types, sherds of the early varieties of Progreso White which is diagnostic of the Pavon remains of the Panuco region (Squier, pers. commun.). One can infer therefore, that Pavon should date roughly in the same period as early Ajalpan.

The Late Ajalpan Subphase

The late Ajalpan subphase is defined by materials from twelve components that produced a large quantity of artifacts. Dates on thirteen samples have been averaged to produce six rather firm dates (Table 9, nos. 46-51; Fig. 4). The dates range from 708 ± 71 B.C. to 1025 ± 200 B.C. However, cross dates and the dates of the following early Santa Maria subphase combine to provide an estimate that the late Ajalpan subphase existed from about 1150 B.C. to near 850 B.C.

In early components of this subphase were sherds of Mapache Red-rimmed, which occurs also as trade sherds in Trapiche I of Central Veracruz, the Cotorra phase in Chiapas, the San José phase of Oaxaca, and at San Lorenzo in southern Veracruz. The point of origin of this pottery type appears to be the Guatemala coast in the Ocos phase; it continues into the succeeding Cuadros phase. Other pottery types linking many of these phases are: Ocos Buff (wide rocker-stamped variety) and Tilapa Red-on-white, the use of zoned rocker-dentate decoration and zoned brushed finishes (Chiapa I and San Lorenzo excepted), and the occurrence of Ponce Black convex-wall bowls (blackened by having been fired in a reducing atmosphere). Furthermore, San Lorenzo, San José in Oaxaca, Trapiche I, and late Ajalpan have in common finely made bottles with a fire-clouded black and white surface, which we have called Tlatilco mottled bottles. These bottles were apparently traded around the area and indicate cultural connections between the various sites. Types we have called La Venta White Raspada and White-slip Redpaste which are found later in the Santa Maria phase in the Tehuacan Valley (vol. 3) and at Tlatilco in the Valley of Mexico occur earlier in San José, Cotorra, San Lorenzo, Cuadros, and Trapiche I. Kaolin Whitt, found in earliest Santa Maria and in Tlatilco, appears in San José, Cotorra, San Lorenzo, Jocotal, and Trapiche II. Available radiocarbon dates for these phases and complexes are listed in Table 9, nos. 52-64, and Fig. 4 and range between 1150 ± 140 B.C. and 765 ± 105 B.C.

The presence of Ponce Black in late Ajalpan as well as in other phases indicate that the Ponce period of Panuco is roughly contemporaneous with late Ajalpan. Sherds of Trapiche Zoned Dentate and Trapiche Zoned Incised are found in Ts 204, Zones F and F^1, dated 972 ± 92 B.C. and 980 ± 157 B.C. (Table 9, nos. 47, 48), and in Ts 204D, Zone E. There is some evidence, therefore, to indicate that Trapiche I which itself does not have a date, falls in the middle of the Ajalpan phase, which is the period of levels dated 972 ± 92 B.C. and 1025 ± 200 B.C. (Table 9, nos. 47, 46).

Except for the ceramics recently uncovered by Tolstoy and Paradis at Tlakacoya in the Ayotla, Justo, and Bomba subphases, there are few resemblances to late Ajalpan materials. These related materials have radiocarbon determinations of 940 ± 80 B.C. (Y-2353) for Bomba, 1030 ± 100 B.C. (Y-2352) for Justo, and 1070 ± 80 B.C. (Y-2354) for Ayotla. Also, one of the burials at Tlatilco, no. 193, which has often been classified as of the middle Tlatilco or Totolica subphase (Piña Chan 1958: 11) had carbon remains dated as 990 ± 250 B.C. (Table 9, no. 65). However, we noted that the ceramics associated with the burial could well be pre-Iglesia, and on similar grounds Tolstoy and Paradis have now classified the burial as of the time period of the Justo subphase, which in their sequence precedes Iglesia. These dates from the Valley of Mexico with related late Ajalpan ceramic remains agree with the radiocarbon determinations for our subphase.

In volume 3 we noted that few ceramic connections have been uncovered between the late Ajalpan subphase and contemporary cultures in the Valley of Mexico. There are, however, a number of radiocarbon dates on levels in the Valley of Mexico which are roughly comparable to the Ajalpan time period, and it is pertinent to examine some of these. Heizer and Bennyhoff (1958), excavating in Mound 1 at Cuicuilco, secured a series of radiocarbon dates which they believe are associated with a new ceramic complex called Tlalpan. These dates are as follows: fill of middle Zacatenco mound, 1870 ± 100 B.C. (UCLA-598), 1980 ± 100 B.C. (UCLA-600), 2100 ± 75 B.C. (UCLA-212), 4765 ± 90 B.C. (UCLA-211); and basal layer of the mound, 1900 ± 200 B.C. (UCLA-599), 1370 ± 100 B.C. (UCLA-597), 2160 ± 120 B.C. (UCLA-601), 2030 ± 60 B.C. (UCLA-210). From a brief examination of the sherds of this presumed complex no relationships or resemblances can be discovered to the ceramics of late Ajalpan, or for that matter, to any of the ceramics anywhere else in Mesoamerica. Furthermore, none of the Cuicuilco dates are on archaeological features or levels which are definitely associated with the ceramic complex. The dates also are not internally consistent. For these reasons they should not, for the present at least, be accepted.

One date, 1360 ± 250 B.C. (C-196), is listed as being on an early Zacatenco sherd layer, and another date, 1457±250 B.C. (C-199), is on carbon taken from various burials at different depths at Tlatilco. These dates are not useful because the deposits including the samples were not carefully excavated, and we have no descriptions of the associated potsherds. The date, 1474 ± 230 B.C. (C-423), is on the fill of the Temple of the Sun at Teotihuacan, and another, 4440 ± 300 B.C. (C-198), is on a sample which was picked out of a bank below the Tlatilco burials. These latter two samples are rejected as not being useful because they are not clearly associated with definite ceramic horizons or archaeological components.

The Early Santa Maria Subphase

Early Santa Maria is one of the most completely defined subphases of the Tehuacan Valley. It has a large sample of new indigenous pottery types, about half of which are distinct from types in any other area. The remainder of the types, such as Canoas White, Heavy Plain, and Black-on-orange, are correlative with types from many widely distributed areas. Also, early Santa Maria levels produced relatively numerous trade sherds which again are from widely distributed areas. Dating of the subphase is based on the radiocarbon dates on twenty-three samples from seventeen components submitted for determination (Table 9, nos. 66-76; Fig. 4).

In trying to employ the radiocarbon dates from early Santa Maria levels to build the chronology, we find ourselves practically midway between the position where a few dates scattered in a sequence permit easy estimates and the situation where a large number of dates can provide definite information concerning times involved. The early Santa Maria dates indicate a trend and some rather firm points in the chronology, but they are not a measure of finite intervals in the sequence. The problem is quickly visualized by inspection of the dates on Fig. 4, key numbers L6-29 through L6-39 (Table 9, nos. 66-76). The trend of the dates from 766 ± 68 B.C. to 608 ± 92 B.C. is interrupted by four dates (Table 9, nos. 67, 68, 72, 74) which appear to be too old. In judging the significance of this observation we note first of all that the date 800 ± 60 B.C. (Table 9, no. 74) is from Tr 15, the Purron Dam in the Arroyo Lencho Diego, and it is quite possible that the charcoal of the sample was not contemporaneous with the spillway as originally believed. The other two dates from Ts 367, Zone C (Table 9, no. 72) and Ts 368e, Zones H and F (Table 9, nos. 67, 68) because of the manner of their collection, may also be in error. Such ex post facto observations are tempered by the fact that the range of the means of the dates, not including the ones in question, is but 158 years, and actually, given the errors, the suspected dates are not as far out of line as the first glance suggests. In other words, the relatively short span of time between about 800 or possibly 850 B.C. and 650 B.C. is established as firmly as the number of dates available permit.

The question of the actual length of the period during which early Santa Maria existed involves the significance of the trade materials and the effect of cross dates upon the chronology. The series of dates from three other regions, the Olmec area, the Valley of Mexico, and Chiapas, require judgments analogous to those made for Tehuacan. But because we lack familiarity with the materials, we have either to take the dates at their face value or consider various discussions and interpretations. In the following paragraphs we make note of the fact that early Santa Maria includes materials which are one hundred or more years older in localities such as La Venta, and so we estimate that Santa Maria began earlier than the actual radiocarbon date we have. The estimate must be in the form of a working hypothesis. Another explanation may be offered in the future when a large and more complete mass of data accumulates. It may be demonstrated, for example, that the congeries at Tehuacan called early Santa Maria and those of La Venta are part of a larger widely dispersed unit. It may well turn out that the later dates in the Tehuacan Valley are caused by complex cultural diffusions from earlier sources such as La Venta. There will always be a difficulty presenting final determination of the details of the chronology because the spans of time are so short and the finer details so minute that assignment of precise dates is not possible with the crude data available.

Zone H of Purron Cave, which falls at the very end of early Santa Maria or the very beginning of late Santa Maria, is difficult to place in its correct sequential position because of the limited sherd samples. In volume 3 the zone was attributed on the basis of pottery types to the end of the early Santa Maria subphase. However, trends of vessel forms indicate that the zone belongs in late Santa Maria. Two dates on the same sample average 445 ± 101 B.C. (Table 4, nos. 4, 5), which may indicate the time of transition between early and late Santa Maria.

Unfortunately, at the time of writing, there are no radiocarbon dates for the phase most closely related to early Santa Maria, the Guadalupe phase of Oaxaca, which has almost the same pottery and figurine types. Another phase that is closely related to early Santa Maria and which is presumably of the same period is Trapiche II of central Veracruz. The three phases have a number of pottery and figurine types in common and share as well a complex of trade types (see vol. 3 of this series, chap. 12).

La Venta, Tabasco, of the general southern Veracruz region, is also closely related to early Santa Maria. Nine radiocarbon dates provide the basis for estimates of age (Table 9, nos. 77-85). We suspect that the dates 1160 ± 300 B.C. and 990 ± 80 B.C. (Table 9, nos. 77, 78) probably date carbon from earlier Pre-La Venta or San Lorenzo levels and that the remaining dates indicate that "Complex A" probably dates between about 950 and 550 B.C. The beginning dates are a little earlier than those for early Santa Maria, and overlap the dates for that period, and we venture the opinion that La Venta does begin a little earlier. One reason for this is that figurine types characteristic of early Santa Maria were first made in the region including La Venta. As explained in volume 3, chapter 12, there are a number of overlapping pottery and figurine types and a shared complex of horizon styles.

Another group of phases related to early Santa Maria are Dili and Escalera from Chiapas. Santa Maria has trade wares from that area, including Dili Punctate, Escalera Orange, and Dili Resist with Red-on-orange negative painting, and has figurine types in common. Radiocarbon dates on the Dili phase are 780 ± 150 B.C. and 928 ± 60 B.C. (Table 9, nos. 86, 87). There are no radiocarbon dates for Escalera, but it appears to date between about 750 and 500 to 560 B.C. It has the same white pottery type as the Xe phase of Altar de Sacrificios, the Peten of Guatemala, which is dated 745 ± 185 B.C. (Table 9, no. 88). Escalera is followed by the Francesca phase, radiocarbon dated 560 ± 45 B.C. and 429 ± 60 B.C. (Table 9, nos. 89, 90). Furthermore, Francesca (and perhaps Escalera which is incompletely described) and two early levels of late Santa Maria include sherds of Mars Orange, a type which is diagnostic of the Mamom phase of Uaxactun and the Tzec phase of Tikal. The Tzec phase at Tikal has a radiocarbon date of 456 ± 47 B.C. (Table 9, no. 92) and the related Eb phase is dated at 588±53 B.C. (Table 9, no. 91). The preceding relationships can be extended to include Conchas 1 of the Pacific coast of Guatemala, which has a date, 790 ± 70 B.C. (Table 9, no. 93), and Conchas 2, 510 ± 130 B.C. (Table 9, no. 94). Other dates on the Conchas phase at Victoria, Guatemala, are 200 ± 240 B.C. (W-836) and 130 ± 240 B.C. (W-837). These are rejected because they appear to be in error, perhaps because they were determined on shells.

Much more knowledge, and additional accurate dates, are needed before it will be possible to cross date a number of phases from highland Guatemala with late Ajalpan or early Santa Maria in the Tehuacan Valley. For example, Majadas has a date of 1020 ± 200 B.C. (C-886), Miraflores, 1192 ± 240 B.C. (C-884), and Providencia, 1196 ± 300 B.C. (C-879). These dates should be discarded despite some internal consistency because they cannot be aligned with the stratigraphy or with other dates in the chronology. Also, C-879 and another date cited by the *Handbook of Middle American Indians* (1:494) should be expunged from the literature. The other date is C-885, supposedly referring to Las Charcas. There is no record of either date having been determined in the source cited in the *Handbook* (Libby 1955). It is also true that the archaeological materials from these phases have little resemblance to either late Ajalpan or early Santa Maria and to the early ceramics from Chiapas, the Peten, and the Pacific coast of Guatemala.

In contrast to the many relationships between early Santa Maria and the phases to the southeast, there are only a few relationships with levels in the Valley of Mexico, and these are of a different nature. Instead of having related pottery types in common, the people responsible for the Tehuacan phases received directly from the Valley of Mexico pottery and figurines made there and brought to Tehuacan. Many of these trade wares relate early Santa Maria to subphases found at Tlatilco, Iglesia, and Totolica. A later subphase, Atoto, is equated with late Santa Maria. Dates for the subphases are Iglesia, 810 ± 160 B.C. (Table 9, no. 95), and Totolica, 575 ± 250 B.C. and 710 ± 50 B.C. (Table 9, nos. 96, 97). We may infer from the dates available that approximate limiting dates for Iglesia are 900 to 750 B.C. and for Totolica, 750 to 600 B.C. Dates for Atoto are estimated to be 600 to 400 B.C., as will be shown more fully below.

Many of the pottery types found at Tlatilco are distributed through the Tehuacan sequence beginning with the components assigned to the early Santa Maria subphase. These types include: Kaolin White, White-slip Red-paste, Morelos Lacquer, white ware with raspada decoration, a hard buff type, and large hollow white figurines. Significantly, certain of the diagnostic types of the three subdivisions of Tlatilco appear in about the same order in the sequence of Santa Maria components. Figurine Types Early F, C3a, and C3d and perhaps the Tlatilco mottled bottles may be diagnostic of Iglesia; they appear in Ts 368e, Zones I-E, which are early levels at Coatepec, and in Zones D^2 and D^1 of Ts 367. This distribution supports the dating of the Tehuacan components from about 800 to 500 B.C.

Totolica diagnostics, such as Morelos Lacquer ware, Types Dii, early F, C3a and C3d figurines are present in Zones F-D of Ts 368e. Totolica can be dated generally between 750 and 550 B.C.

A number of trade sherds from middle Zacatenco levels, which are contemporaneous with Totolica, are found in early Santa Maria components. These include a Zacatenco Orange grooved-lip incurved-rim sherd, thirteen Zacatenco Brown olla sherds, and seventeen Brown Incised bowl sherds, and two Zacatenco Red-on-white sherds. Middle Zacatenco has been dated by several determinations, one at Zacatenco, 500 ± 250 B.C. (Table 9, no. 98), and three at Cuicuilco, 540 ± 60 B.C., 610 ± 80 B.C., and 610 ± 100 B.C. (Table 9, nos. 99-101).

As has been mentioned in volume 3, some of the white wares from El Arbolillo, Tlatilco, and Zacatenco strongly resemble white wares of Tehuacan, although they are not the same types. For example, a white ware of the Valley of Mexico, as well as Chila White of the Aguilar and Chila phases of Panuco, are particularly close to Coatepec White of Tehuacan. Also many of the unpolished white wares from the Valley of Mexico, particularly those from Tlatilco with curvilinear designs on the interior bottom surface of tripod bowls, are more closely related to Progreso White variants of the Aguilar phase of Panuco. One can surmise that the latter phase is of the same period as Tlatilco and early Santa Maria.

In short, there is considerable evidence for assigning early Santa Maria and several phases distributed from Tampico to Guatemala to the same period. The accepted radiocarbon dates from many of these phases, including the early Santa Maria subphase of Tehuacan, indicate that the period dates approximately from 850 to 500 B.C.

Late Santa Maria Subphase

There are only two dates on late Santa Maria levels from the Tehuacan Valley. One of these, on a sample from Zone B of Ts 368e, 45 ± 100 B.C. (Table 9, no. 102), is so late that even the limits of the one sigma error hardly reaches our estimates of the date of termination of this subphase. The second date, 445 ± 101 B.C. (Table 9, no. 103) is on a sample from Zone H of Tc 272. As noted above, this zone also has some attributes which can be classified as late early Santa Maria, and the continuity from one subphase to the others may be assumed.

As will be shown below, distribution of trade sherds from surrounding regions, including well-defined phases in the Valley of Mexico, indicate that the sequence of late Santa Maria begins about 500 B.C. and ends about 150 B.C.

In late Santa Maria levels there is a group of pottery and figurine types which come from Ticoman subphases in the Valley of Mexico. Such types are also present in the late Zacatenco subphase which is roughly the equivalent of Ticoman I or the Atoto phase. Excepting the date 650±70 B.C. (Table 9, no. 106), which is too old, several dates place Atoto in the century between 500 and 400 B.C. (Table 9, nos. 104-107). Some of the pottery and the characteristic Type E and figurine head and body types were present throughout the Ticoman I-III periods (or the Atoto, Cuanalan, and Tezoyuca phases) indicating that the types were in existence from about 500 to about 150 B.C. Some of these pottery types are diagnostic of the Ticoman I-III subperiods, and because they do appear in late Santa Maria components they permit cross dating the latter somewhat more precisely.

Atoto diagnostic types are Cerro or Loma del Tepalcate Punctate, black or gray raspada wares, and Negroid with Hairknot figurines. These are found in middle Santa Maria phase components, roughly from Zone D to Zone C in Ts 368e. We note that body fragments of Ticoman figurines were the only Valley of Mexico figurines found in the earliest of the late Santa Maria components.

There is but one date from Ticoman II, 315 ± 53 B.C. (Table 9, no. 108) and from this, and particularly, the alignment of other data, we infer that the subphase existed during the century between 400 and 300 B.C. Type G figurines, a diagnostic Ticoman II type, are found in Tehuacan in Ts 368w, Zone B^1 and in Test 10 of Tr 218, Zone C^1. This is the basis for an inference that the middle components of late Santa Maria fall in the general period 400 to 300 B.C.

Ticoman III, presumably dating between 300 and 150 B.C., includes the diagnostic figurine type we call Ticoman. This type is found at Tehuacan in Test 10 of Tr 218, Zones C and B^1. This occurrence is an indication that these Tehuacan components were probably contemporaneous with Ticoman III, and it supports the opinion that the other later components of late Santa Maria fall in this general time period.

The chronological influences concerning late Santa Maria are confirmed by the relationships between these Tehuacan levels and Monte Alban periods in Oaxaca. Monte Alban I levels have the following dates: 650 ± 170 B.C. and 390 ± 275 B.C. (Table 9, nos. 110, 111). Monte Alban II has three dates: 273 ± 145 B.C., 250 ± 70 B.C., and 40 ± 110 B.C. (Table 9, nos. 112-114). The dominant ware of late Santa Maria is Quachilco Gray, and the same type, or a very close relative, is the dominant type in Monte Alban I and II. Also, examples of Quachilco Brown were traded into Monte Alban I. Two Monte Alban I figurine types are found in Zones B and C of Ts 368e, which tends to confirm the fifth century B.C. estimate for these levels based originally on Ticoman associations. Also, a white-slipped ware of Monte Alban I and II is very similar to Coatepec White, a common type in late Santa Maria components. As we have pointed out, Coatepec White appears to be related to Chila White of the Aguilar and Chila phases of the Panuco region and to some of the late white wares of the Valley of Mexico found throughout the Ticoman sequence.

A type similar to the late white-slipped pottery from Tehuacan sites is found in some abundance in Trapiche III and Early Tres Zapotes in southern Veracruz. Also, Chalahuites Orange-rimmed Black, characteristic of Trapiche III and Tres Zapotes, is found in many late Santa Maria levels in the Tehuacan Valley. Sherds of Tres Zapotes Black Incised were found in Test 11 of Tr 218, Zone F, and Ts 368e, Zone B^1. Materials resembling those from the Middle Tres Zapotes phase come from the post-complex A levels at the La Venta site which are dated 450 ± 250 B.C., 430 ± 60 B.C., and 180 ± 300 B.C. (Table 9, nos. 115-117) (the UCLA dates 902, 903 and 1287 are not used here). The famous stela which appears to be associated with the remains of early Tres Zapotes bears a bar-and-dot date which has been translated as 31 B.C. (Thompson correlation). Many gray sherds from the Ranchito collection, which may be Early Tres Zapotes, are extremely similar in form and decoration to Quachilco Gray of late Santa Maria.

The relationships extend further to the south, for Quachilco Gray, or a close relative of it, occurs as a trade ware in the Francesca, Guanacaste, and Horcones phases of Chiapas. Dates averaging about 500 B.C. (Table 9, nos. 89, 90) have already been noted for Francesca, which also has trade sherds from Tres Zapotes. Guanacaste has a date 220 ± 50 B.C. (Table 9, no. 118), and Horcones has two dates, A.D. 30 ± 45 and 40 ± 65 B.C. (Table 9, nos. 119, 120) Mars Orange first appears in late Santa Maria levels in Tehuacan (Ts 368e, Zones B and C), the Tzec phase at Tikal (Table 9, no. 92), and in Francesca of Chiapas. It also appears in Mamom, an early phase at Uaxactun, which, though undated, is the equivalent of the San Felix phase of Altar de Sacrificios. The dates for San Felix (Table 9, nos. 121-123; Fig. 4) fall generally in the range of late Santa Maria. Some estimates suggest earlier dates for the Peten phases, but these latter are not compatible with the data presented here and we believe them to be in error. Mars Orange is also found in Horcones in Chiapas and in the Chicanel phase at Uaxactun and the Cauac and Chuen phases of Tikal. Cauac has the following dates: 267 ± 63 B.C. and 125 ± 49 B.C. (Table 9, nos. 124, 125), and two dates which analysis of pottery type distribution shows are too late: A.D. 16 ± 63 and A.D. 76 ± 54 (Table 9, nos. 126, 127). The Chuen phase bears the following dates: A.D. 20 ± 51, 67 ± 52 B.C., 118 ± 52 B.C., 114 ± 52 B.C., 275 ± 55 B.C., 219 ± 52 B.C., 90 ± 53 B.C., 207 ± 52 B.C. (Table 9, nos. 128-135).

Late Santa Maria in the Tehuacan Valley is tied to the chronology of highland Guatemala by the presence, among others, of Usulutan ware. This ware, which is also found in the Horcones complex in Chiapas, is widely distributed, including the lower levels of the Chukumuk site on Lake Atitlan, which also produced pottery attributed to the Miraflores phase (Kidder, Jennings, and Shook 1946: 243). Miraflores mound fill has been dated 75 ± 60 B.C. (Table 9, no. 141). Other dates, A.D. 10 ± 60 (Y-377) and A.D. 30 ± 60 (Y-382), are, we believe, very much too late, and for this and other reasons, have not been included in these chronological discussions. The Arevalo phase of the same region, which is reputedly roughly contemporaneous, has two dates, 290 ± 60 B.C. and 120 ± 50 B.C. (Table 9, nos. 139, 140). Also, the Majadas phase and the presumably somewhat earlier Las Charcas phase of highland Guatemala are dated 385 ± 50 B.C. (Table 9, no. 138) for the former and for the latter, 390 ± 50 B.C. and 330 ± 130 B.C. (Table 9, nos. 136, 137).

Although late Santa Maria is well documented by components in the Tehuacan Valley, unfortunately dates are scarce. The correlation of the wares in dated components of widely distributed regions presents a complex fabric which cannot be completely unraveled. However, the distribution of trade sherds has rather convincingly substantiated the estimate that late Santa Maria and a number of analogous phases existed in Mesoamerica during the general period from about 500 to 150 B.C.

The Early Palo Blanco Subphase

Early Palo Blanco in the Tehuacan Valley has one dated floor, Zone VI of Coxcatlan Cave, A.D. 180 ± 100 (Table 9, no. 142) and a burial that is dated A.D. 5 ± 200 (Table 9, no. 143). The subphase is defined by nine components, excepting the three upper zones of Tr 218, however, they had limited numbers of sherds and few trade sherds. Three pottery types found in early Palo Blanco are also present in the late segment of the phase, but because of their wide distribution they are only of general significance. One of these types is El Riego Black; as we have pointed out in volume 3, it appears to be related to San Martin Incised, which is found throughout most of the Teotihuacan sequence in the Valley of Mexico. The parallel distribution in Tehuacan and the Valley of Mexico is evidence that Palo Blanco was contemporaneous with the Teotihuacan sequence.

El Riego Gray, one of the gray wares found in late Santa Maria levels but more common in early and late Palo Blanco, has features in common with gray wares of Monte Alban II and III and indicates contemporaneity. Thin Orange is present in nearly all but the very earliest Palo Blanco component; it first appears in the Teotihuacan sequence in the Tzacualli subphase. Therefore the date for Tzacualli A.D. 1 to 160, as noted below, may roughly date Zone A of Test 6 of Tr 218, the earliest zone in Tehuacan Valley sites in which Thin Orange is found.

Even though meager in number, figurines from early Palo Blanco make it possible to trace the overlapping or recurrence in other areas of styles found locally in the Tehuacan Valley. A Remojadas type found in one of the earliest components of Palo Blanco has various affiliations with figurines of the Lower Remojadas phase on the Veracruz coast and in the phase which Coe (1965: 686) designates as Cerro de las Mesas II. Also some of the figurines from the above phases are similar to the Slot Feature type which is found in several of the latest Santa Maria components and the earliest Palo Blanco component. This latter type of figurine and the Doughnut-eye types have their closest affiliations with the Oaxaca Valley during Monte Alban II times. It has been noted that three dates for Monte Alban II range from 273 ± 145 B.C. to 40 ± 110 B.C. (Table 9, nos. 112-114). A better link between Monte Alban II and early Palo Blanco can be seen in specific features shared by El

Riego Gray and Monte Alban vessels such as ring bases, double bridged spouts, wide everted rims, stepped rims, barrel-necked and rolled-rim ollas, and cylindrical, mammiform, bulbous, nubbin, and hollow rectangular feet.

Early Palo Blanco figurine types, Ticoman, Slot Feature (like Type Hiv) and the hand-modeled Tehuacan Portrait figurines are clearly correlative with types found in the early part of the Teotihuacan sequence in the Valley of Mexico. The Ticoman and Slot Feature figurines and even the Doughnut-eye type are closely related to the figurines of Teotihuacan I, or the Patlachique and Tzacualli phases. Patlachique has been dated about A.D. 1 ± 80 (Table 9, no. 144), and Mound 2 at Cuicuilco seems to be related to Patlachique, for though the description of the sample raises grave doubts, some assign to it the date 90 ± 200 B.C. (Table 9, no. 145). Tzacualli phase samples have been dated A.D. 160 ± 75, A.D. 20 ± 80 and A.D. 145 ± 120 (Table 9, nos. 146-148). The hand-modeled portrait figurines from Tehuacan are extremely similar to the figurines of Teotihuacan II or Miccaotli and early Tlamimilolpa phases. Only Tlamimilolpa has been dated: at A.D. 230 ± 65 (Table 9, no. 149). The Tehuacan and Teotihuacan portrait figurines are very similar to the portrait type of the Pithaya phase (Ekholm's period III) of Panuco, suggesting that Pithaya dates from the same period as early Palo Blanco and Patlachique, Tzacualli, Miccaotli, and early Tlamimilolpa of the Valley of Mexico, i.e., from A.D. 100 to 250.

The following traits are also common to the early Palo Blanco and Valley of Mexico phases: engraved or carved decoration, bowls with wide everted rims, stepped-rim bowls, bowls with basal ridges, rolled-rim ollas, ring bases, spout handles, plain pot covers, cylindrical vessels with or without mammiform feet, and vessels with small bulbous or hollow cup-shaped feet, nubbin feet, and, near the end of the period, hollow rectangular feet. In addition, Thin Orange pottery is present in these phases. Approximately the same traits appear in other regions farther south, for example, in Chiapas in the Horcones, Istmo, and Jiquipilas phases. As noted above, Horcones has been dated at A.D. 30 ± 45 and 40 ± 65 B.C. (Table 9, nos. 119, 120). Istmo has two dates, A.D. 105 ± 50 and A.D. 80 ± 200 (Table 9, nos. 150, 151). The latter date is on a sample originally listed as of the "Piedra Parada" phase of Santa Marta Cave, and its pottery, according to Gareth Lowe (pers. commun.), has affinities with the Istmo phase of the Chiapa de Corzo sequence.

Many of the traits listed in the previous paragraph are also found in the Matzanel and Tzakol phases at Uaxactun in the Peten. A date, A.D. 170 ± 60 (Table 9, no. 152) may be on early Tzakol remains. At Tikal in the same region, these traits are found in the Cimi and Muluk ceramic periods. Cimi samples are dated A.D. 24 ±48 and A.D. 173±45 (Table 9, nos. 153, 154). A sample which appears to belong to the Muluk phase is dated A.D. 201 ± 59 (Table 9, no. 155).

In highland Guatemala, south and west of the Peten, some of the early Palo Blanco traits are found in the Aurora and Santa Clara phases. Aurora is dated A.D. 165±60 and A.D. 90±60 (Table 9, nos. 156, 157), and Santa Clara A.D. 150 ± 60 (Table 9, no. 158).

The preceding listings confirm the dates determined on early Palo Blanco remains in the Tehuacan Valley (Table 9, nos. 142, 143). The data also support our estimate that the subphase was in existence between about 150 B.C. and A.D. 250. Cross dating various levels, using mainly pottery types, suggests that the components in the Tehuacan Valley, Tr 218, Test 10, Zone A; Tc 307, Zone A; and Tr 218, Test 11, Zone A, which do not include Thin Orange, may date from about 150 B.C. to A.D. 1. The remaining components were in existence during the later part of the time period, lasting until about A.D. 250.

The Late Palo Blanco Subphase

The late Palo Blanco subphase is represented in the Tehuacan Valley by eleven components which produced a limited number of figurines and about 3,000 potsherds. The dates on three components range between A.D. 187±96 and A.D. 325±150 (Table 9, nos. 159, 161). These dates do not cover the whole range of time during which we estimate late Palo Blanco existed, because the samples dated represent only the older part of the subphase. Comparative data to be described is the principal basis for estimating that late Palo Blanco commenced about A.D. 250 and lasted to about A.D. 700.

The closest affiliations of late Palo Blanco are with the late Tlamimilolpa phase of the Valley of Mexico, the early parts of which may be equated with early Palo Blanco, and with the Xolalpan and Metepec phases of the same region (Teotihuacan III and IV). The dates accepted here for these phases are given in the accompanying tabulation and in Table 9, nos. 162-173. Scrutiny of this list supports in general our estimates that the phases of Xolalpan and Metepec were contemporaneous with the first part of late Palo Blanco, despite a number of dates which are slightly earlier and only one of which can be later than A.D. 700, our limiting figure.

Xolalpan

A.D. 200 ± 80
A.D. 200 ± 80
A.D. 160 ± 80
A.D. 250 ± 80
A.D. 290 ± 80
A.D. 150 ± 80
A.D. 170 ± 80
A.D. 200 ± 80
A.D. 370 ± 80
A.D. 290 ± 80
A.D. 330 ± 80

Metepec

A.D. 660 ± 80

The rather close relationship beween late Palo Blanco and Xolalpan and Metepec is based on the trade wares, ceramic features, and other materials found in late Palo Blanco levels. Discovered in these levels were a red, yellow, and green fresco-decorated sherd of a ware which is typical of Xolalpan and three San Martin Stamped sherds characteristic of Metepec. The mold-made Tlaloc figurines of late Palo Blanco apparently originated in Xolalpan and a small mold-made figurine with a radiating headdress appears similar to specimens from Metepec. Tombs 1 and 2 excavated from a mound near the old cathedral in the city of Tehuacan contained a number of vessels typical of these Teotihuacan phases. Concerning these vessels Noguera (1940: 309-310) reported:

> Vessels of thin orange ware predominate, with incised and carved designs. There are also bowls of the same ware with cylindrical legs and vases of artistic value having smooth sides and crenelated legs and the base surrounded with tiny little heads, a detail typical of Teotihuacan. Two of these boast a sculpture in the round, one of a tiger, another of a monkey [which is mold-made]. Common also are small vases, with flat bottoms and conical or cylindrical legs, equipped with covers, as well as cups of brown ware, bowls of cream ware with a finely polished cerise slip, and others of less archaeological significance and inferior artistic value.
>
> Along with pottery objects were found in both tombs specimens of jade, such as rings, discs, beads, and plaques, all destined for personal ornament. Knives, blades, and beads of obsidian, as well as various ornaments of bone and shell occurred to say nothing of stone metates, metalpilis, and polishers, but the most valuable thing archaeologically speaking because of its rarity, was without doubt a little wooden idol, still in relatively good condition.

The little wooden idol is almost identical to some of the Tlaloc figures painted on constructions at Teotihuacan.

Two pierced barrel-shaped disks, probably spindle whorls, were found in Zone D of Tc 35e, a late Palo Blanco level. These are identical to spindle whorls appearing in Metepec, at Zaquil, and in Period IV of Panuco. It is possible that these are rather good markers for the early Classic.

In addition to the specific features which tie Xolalpan and Metepec to late Palo Blanco, the phases hold in common a number of general horizon markers such as ring bases; both tall and low cylindrical vessels; cylindrical, rectangular, bulbous and nubbin feet; covers that are often decorated; funnel-neck and barrel-neck ollas; mold-made figurines; carved decorations, etc. One can observe also that El Riego Marble-tempered comales with polished interiors and roughened exteriors are much like the San Martin dark brown ones found in Xolalpan and Metepec. Orange Plain and El Riego Black resemble San Martin Incised; El Riego Orange is similar to San Martin.

There are many features which indicate that late Palo Blanco is similar to Monte Alban III in Oaxaca. Dates on Monte Alban III material are A.D. 298±185, A.D. 540±100 and A.D. 720±100 (Table 9, nos. 174-176). John Paddock informs us that the first two dates are on beams from the same tomb, Tomb 1 at Yucuñadahui. Concerning the latter of the two he notes that the new sample, I-2680 (175), was obtained from a watchman at the site and writes, "Because this tomb is of prime importance in several respects, a new date on it is of special interest. Ceramics in the tomb were mostly rather different from those of Monte Alban . . . Nevertheless, Caso and Bernal agreed that some items had strong resemblance to the ceramics of Monte Alban at the time of transition from IIIa to IIIb" (Paddock corres. 1967). The date A.D. 720±100 (Table 9, no. 176) was determined on a sample from an offering associated with late Monte Alban IIIb or IV pottery. These dates fall within the estimated time range of late Palo Blanco.

El Riego Gray and Monte Alban III Type G have many features in common. Similar types of incense burners are common to both late Palo Blanco and Monte Alban III. Noguera (1940) in his report on Tombs 1 and 2 in Tehuacan long ago recognized the relationship between late Classic gray pots he found to those from Monte Alban III. Another resemblance between the two phases can be seen in the similarity of trade sherds found in both. In Monte Alban III, as in late Palo Blanco, one finds examples of Thin Orange, San Martin Fresco-decorated, San Martin Incised, and San Martin Stamped. Furthermore the architectural characteristics of the two complexes are very similar if not identical.

Pottery types characteristic of Xolalpan and Metepec are widely distributed over Mesoamerica in such a way that they can be used to date the phases in many areas. Tajin II in central Veracruz reputedly has many Xolalpan and Metepec types, as does Cerro de las Mesas III (Coe 1965). There are no radiocarbon dates for these two phases, but Cerro de las Mesas has two dated stela: Stela 6, with a long-count date of A.D. 468 by the Thompson correlation, and Stela 8, dated by the same method A.D. 533.

From Chiapas we note "three burial offerings of Teotihuacan-like vessels" in tombs of the Laguna IX phase (Lowe and Mason 1965). In the Mirador-Soyatenco region many similarities and a number of sherds which appear to be trade pieces attest to relationship with Xolalpan and Metepec. Jiquipilas (Chiapa VIII) is mentioned as having Ixcanrio Orange Polychrome from Tzakol 1, while Laguna may have Dos Arroyos Polychrome from Tzakol 2-3 of lowland Guatemala. Also, the Tzakol phase of the Peten has trade pieces of Thin Orange, San Martin Fresco-decorated, and San Martin Stamped and San Martin Incised, as well as many other traits from Xolalpan and Metepec. Tzakol does not include mold-made figurines. However, Dos Arroyos Polychrome of Tzakol 3 appears in Xolalpan and Metepec and, according to Millon (1966), there may be Tepeu I sherds in late Metepec deposits. There are no radiocarbon dates from Tzakol periods at Uaxactun, but there are sherds from these periods associated with carved monuments, which range in time, according to the Thompson correlation, from A.D. 278 to about A.D. 700. At nearby Tikal in the Manik and Ik phases, there are sherds proving relationships with late Palo Blanco and also trade sherds from Xolalpan and Metepec. The ceramic remains from Tikal are associated with dated monuments which are roughly contemporaneous with the corresponding Tzakol periods at Uaxactun. The long series of radiocarbon dates for the two phases at Tikal are given in Table 9, nos. 177-186, and in the accompanying tabulation.

Manik		*Ik*
A.D. 325 ± 60	A.D. 210 ± 50	A.D. 676 ± 50
A.D. 420 ± 50	A.D. 230 ± 60	A.D. 746 ± 34
A.D. 400 ± 58		A.D. 684 ± 37
A.D. 600 ± 52		A.D. 625 ± 26

The Chakan phase of Yucatan (Early Period, Phase I, Andrews 1965) in which Ixcanrio Orange and Tzakol Polychrome are found is dated A.D. 430±200 (Table 9, no. 188), and Motul including Tepeu types of polychrome pottery is dated A.D. 450±200 and A.D. 500±200 (Table 9, nos. 189, 190). A date on Tepeu I is a little later, A.D. 620±70 (Table 9, no. 187). At Kaminaljuyu, in highland Guatemala, tombs of the Esperanza and Aurora phases include a large number of trade pieces from Miccaotli and Xolalpan. There are a number of radiocarbon dates on the Esperanza and Aurora materials which are relevent to the dating of Teotihuacan, and significantly here, of late Palo Blanco: A.D. 390±70, A.D. 290±60, and A.D. 350±50 (Table 9, nos. 191-193).

In the Tiquisate or San Francisco phase on the Guatemala coast are found many Teotihuacan and Tzakol sherds. Radiocarbon dates on the San Franciscan phase — renamed Mejor es Algo and Lagunita by Parsons (1967) — are A.D. 260±110, A.D. 390±120, A.D. 490±120, A.D. 527±136, A.D. 600±120, and A.D. 650±130 (Table 9, nos. 194-199).

The remains in Tamaulipas are almost as distant from the Palo Blanco materials in Tehuacan as are the sites in Guatemala. However, the Eslabones phase in Tamaulipas includes wares which originated in Teotihuacan. H.B. Nicholson found in his excavation on the Laguna de Moctezuma two pots of the San Martin Stamped type and one San Martin Incised pot (pers. commun.). Samples associated with these pots were dated A.D. 600±105 and A.D. 1±110 (Table 9, nos. 200, 201). The Eslabones phase has its closest connections with the Pithaya and Zaquil phases of the Panuco region, nevertheless the dates are indirectly relevant to the chronological position of the late Palo Blanco remains. The Palmillas phase remains of the Sierra Madre region of southwestern Tamaulipas include San Martin Incised wares and Zaquil sherds which relate to the Zaquil phase at Panuco. Palmillas remains have been dated A.D. 230±200 (Table 9, no. 202).

In our search for radiocarbon dates useful in dating the period of the late Palo Blanco phase, we have found acceptable forty-one dates on samples distributed from Tamaulipas in the north to lowland Guatemala in the south and west and Yucatan to the south and east (Table 9, nos. 162-202). Plotting these dates, but not the errors, on a curve shows that the median is approximately A.D. 250, our estimate for the time when the late Palo Blanco subphase began. More than half the dates fall before about A.D. 350, and only eight dates are more recent than A.D. 550. For the beginning of the phase there are three dates older than A.D. 150 and the largest number in a single unit, seven, is in the range A.D. 151 to 200. Taken in arbitrary geographical units we find that the dates from the Petén range from A.D. 210 to 746. In Oaxaca the spread is A.D. 298 to 720; in the Valley of Mexico, A.D. 150 to 660; in Yucatan, A.D. 430 to 500; in Guatemala A.D. 90 to 527; and in Tamaulipas, A.D. 100 to 600. These ranges are compared with that from Tehuacan, A.D. 187 to 325. These groups of dates reflect two problems: the number of dates determined is not relatively consistent from area to area and the probability exists that age determination are not representative of the full chronological range of sequences which are comparable to what we have classified as late Palo Blanco. Comparisons of pottery characteristics have established approximate contemporaneity of Classic phases in Mesoamerica. The dates confirm our estimate that the complex we call late Palo Blanco became identifiable about A.D. 250.

The date when this complex began to develop into the following Venta Salada is not so easily defined. Taking into account all information available we have estimated that late Palo Blanco ended about A.D. 700. Available radiocarbon dates suggest that this event could have taken place a century or two earlier.

The Early Venta Salada Subphase

The early Venta Salada subphase in the Tehuacan Valley is represented by only seven excavated components, and these produced an inadequate sample of sherds. There are dates for but two of these components (Table 9, nos. 203, 204; Fig. 4). It is most difficult to date early Venta Salada remains because the data are incomplete. There may be sizable gaps of time between the components, as suggested by rather large shifts in percentages of types from one component to another, and also by the data from the relatively large number of surface sites. In addition, the dating of the trade sherds found in the various components is rendered difficult, because related phases from other areas have rarely been dated by the radiocarbon technique or by other convincing methods. The following discussion is an attempt to assemble and interpret existing radiocarbon dates and the distribution of pottery types.

We noted above that the Palo Blanco subphase may have ended and the early Venta Salada subphase commenced about A.D. 700. There are no early Venta Salada dates which support this figure, the earliest being A.D. 900±110 (Table 9, no. 203), a date on Zone III of Coxcatlan Cave. This zone is separated from the transition of Palo Blanco to early Venta Salada by several zones from other sites. The latest date determined in this subphase was on Zone II of Coxcatlan Cave, A.D. 1100±78 (Table 9, no. 204). This is an average derived from dates on two samples from Level 2 and one sample from Level 3 that ranged from A.D. 900 to A.D. 1300. Its archaeological significance is difficult to assess. It does correspond to our estimate of the approximate date of the transition from early to late Venta Salada. The estimate is based upon the distribution of trade sherds, some of which are found in dated levels.

Tohil Plumbate pottery has long been recognized as an excellent time marker throughout Mexico. The type seems to have had its origin in highland Guatemala, even though radiocarbon dates on the earliest zones including it may not have been determined. In the Tehuacan Valley, Tohil Plumbate was found in a late level of the early Venta Salada subphase and, as well, in an earlier zone of late Venta Salada. The earlier discovery was in Coxcatlan Cave, where one sherd was found in Zone II, which we have dated provisionally at about A.D. 1100±78 (Table 9, no. 204). The pottery type was found at the Nebaj site in highland Guatemala in Tomb VIII, mound 2, a beam of which was dated at A.D. 1180±60 (Table 9, no. 205). It is also found in the Ayampuc phase in the highlands, the dates of which are as yet uncertain. Tohil Plumbate is present in the modified florescent phase of Yucatan and in the Ruiz and Suchiapa phases of inland Chiapas; it is recorded from two levels in the Paredon-Moctezuma site in coastal Chiapas, dated A.D. 1190±100, A.D. 1080±100 and A.D. 1340±100 (Table 9, nos. 207-209). It is also present in the late phases of Isla de Sacrificios of southern Veracruz and in early Monte Alban IV, Oaxaca, with dates A.D. 720±100 and A.D. 890±150 (Table 9, nos. 210, 211). There are many other locations at which Tohil Plumbate is found, among them Mazapan in the Valley of Mexico, Cempoala I and II in central Veracruz, Tikal, Uaxactun, and Altar de Sacrificios. Putting all the data together, we come to the opinion that the life span of this type of pottery is probably somewhere between A.D. 1000 and 1250. This makes the ware a good time marker wherever it appears in Mesoamerica.

The pottery type called X Fine Orange first appears in the Tehuacan sequence in zones classified as early Venta Salada; furthermore, these zones are earlier than Zone II of Coxcatlan Cave, the level at which Tohil Plumbate first appeared. X Fine Orange continues to appear into late Venta Salada and outlasts Tohil Plumbate in the Tehuacan sequence. The locus of origin of X Fine Orange is unknown, but it is assumed to be in the southern part of the Mexican Gulf Coast, perhaps in Tabasco or Campeche (Smith 1958). The date of origin of the pottery type is not well established.

In regions outside the Tehuacan Valley X Fine Orange is usually associated with Tohil Plumbate during the period when the latter was in use. The list of these places follows closely that given above for Tohil Plumbate. We add inland Chiapas and highland Guatemala, in which regions it is dated A.D. 1000 to 1200 (Borhegyi 1965: 46). Smith's analysis of the type in Yucatan and the Petén suggests that it dates from after the end of the Maya Classic (Smith 1958). The date of this period is uncertain but the ware may have originated about 950 and continued in use until 1200 or 1300 (Willey 1966).

Preceding X Fine Orange in many sequences is Y Fine Orange or Balancum or Altar Fine Orange. In the Cehpech complex of northern Yucatan these materials are dated, on the basis of the Thompson correlation of the Maya calendar, in the general period from about A.D. 800-1000 (Smith and Gifford 1965: figs. 2, 4). Y Fine Orange also appears in Tepeu III, in the Petén of Guatemala. Tepeu III materials are usually associated with Maya calendrical dates which fall between A.D. 830 and 950 (Smith and Gifford 1965: fig. 2) and one may assume that Y Fine Orange has a life span lasting roughly from before A.D. 800 to about A.D. 1000.

In Tehuacan Y Fine Orange is found in one of the earliest of the excavated Venta Salada components, Zone C of the East Niche of El Riego Cave. The ware appears in some quantity, and it lasts into Zone B of the East Niche, the level just following the earliest dated Venta Salada component, Zone III of Coxcatlan Cave, A.D. 900±110 as noted above.

Y Fine Orange appears in numerous archaeological, components such as Pamplona of highland Guatemala and Pokom, Department of Quiché, in the same region. The latter is dated A.D. 770±60 (Table 9, no. 212). The list continues with complexes named Boc, Tepeu III, and Exnab of the Petén, Paredon from inland Chiapas, Isla de Sacrificios of the southern Veracruz coast, Coyotlatelco of the Valley of Mexico, and Tajin III in central Veracruz. Collating these and the few dates available leads to the impression that most of these horizons could exist as early as A.D. 800, and they could not be much later than A.D. 1000.

The early Venta Salada components in Tehuacan contained sherds of Mazapan or Tula Red-on-orange, a type which appears in both the Coyotlatelco and Mazapan phases in the Valley of Mexico. It is also found in the Las Flores phase of the Panuco-Tampico region, Tajin III of central Veracruz, and Isla de Sacrificios of southern Veracruz.

Cholula Polychrome Lacquer is encountered in one early and several late Venta Salada levels in the Tehuacan Valley. The type is widespread throughout Mexico. It appears to have been used over a long period of time, perhaps from A.D. 700 to A.D. 1500 and therefore is not useful as a precise time marker. Generally speaking, it spread through much of Mexico apparently after about A.D. 1200 but it is earlier than that in Coyotlatelco, Cempoala, and Tehuacan.

San Juan Plumbate, an important type of trade pottery, was not found in excavations in Tehuacan, but the surface collection of Tr 210, a very early Venta Salada component, contains four sherds. These sherds should date the beginning of the Venta Salada phase about A.D. 700 to 750. San Juan Plumbate appears in many archaeological manifestations in Mexico, such as the Coyotlatelco phase of the Valley of Mexico, the Maravillas phase of inland Chiapas, the Amatle phase of highland Guatemala, and the San Juan phase of coastal Guatemala, where it seems to have originated. None of these phases are well dated by radiocarbon, but San Juan Plumbate is associated with a stela of Copan style that has a calendar date of A.D. 711. In addition there is a radiocarbon date of A.D. 840±80 (Table 9, no. 206) on the San Juan phase remains at the Bilboa site in coastal Guatemala. These remains include San Juan Plumbate.

The above observations comprise the basis for the assumption that early Venta Salada commences about A.D. 700 and lasts until about A.D. 1150. Additional evidence based on artifacts, in a more general way tend to confirm the earlier dating and these phase correlations. All but one of the mold-made spindle whorls of early Venta Salada are undecorated. Undecorated mold-made spindle whorls occur in Mazapan in the Valley of Mexico, Zaquil and Las Flores in the Panuco area, and the Soncautla complex of southern Veracruz.

Mold-made figurines with plain squared or slightly bifurcated headdresses may very well have a similar distribution and link a series of other phases. The use of small side-notched arrow points is a trait linking a number of late manifestations. They appear in the upper levels of Cueva de la Zona in Nuevo Leon, where they date A.D. 785±75, A.D. 970±130, and A.D. 1105±115 (Table 9, nos. 213-215). In Tamaulipas side-notched arrow points first are found in the San Lorenzo and Los Angeles phases. They are also found in Las Flores, Mazapan, Monte Alban IV (A.D. 890±150, Table 9, no. 211) and perhaps some of the manifestations farther to the south in Mesoamerica.

Other features that may connect many Postclassic phases are pottery types decorated by fine lines painted on an orange or buff background. This generalized red-on-orange type is frequently associated with molcajete bowls or pedestal-based vessels. Also, stamped-bottom or *fondo sellado* wares first appear during the general period. This trait is pretty much confined to Isla de Sacrificios, early Cempoala, and Coyotlatelco in the Valley of Mexico. These grater-bowls are a series of different types, all made in local styles, but they appear to be closely connected chronologically during the period between about A.D. 700 to 1150.

The Late Venta Salada Subphase

The final subphase in the Tehuacan sequence is late Venta Salada. There are so many trade sherds from components of this subphase and they are in such variety that there is little question of the close relationship with many other phases widely distributed in Mexico. There are few radiocarbon dates for this last subphase. It commences at the end of early Venta Salada, that is, about A.D. 1150, and continues to the time of the Spanish Conquest, or about 1520.

One of the pottery types that indicates relationship between late Venta Salada and a number of other phases is Isla de Sacrificios Polychrome, made during the Isla de Sacrificios phase in southern Veracruz. This type also appears in Cempoala II and III in central Veracruz. Also linking these same regions is Cerro de las Mesas Polychrome. This is found in late Venta Salada zones in Tehuacan, at Cerro de las Mesas, and in the upper, later phases of Cempoala III and IV.

A group of pottery types widely distributed in Mexico during the years marking the earlier part of late Venta Salada were made at Cholula. These include a type of incensario decorated with large spikes, which we call Cholula Coarse, and the Cholula Polychrome wares designated Lacquer, Matte, and Firme. These types spread widely through Mexico and beyond soon after A.D. 1200 but before the Aztec conquest. They appear in the latest phase on the Pacific coast of Guatemala, in Tuxtla and Urbina of Chiapas, Cempoala II and III, upper Cerro de las Mesas, Monte Alban V, and in Tenayuca levels in the Valley of Mexico; MacNeish has seen Cholula Polychrome sherds from the latest levels at Tamuin in the Huasteca.

Apparently the latest trade wares, which are also widely distributed, are Aztec types such as Texcoco Black-on-red, Texcoco White-and-black-on-red, and Tenayuca Black-on-orange. These types appeared just before the Conquest and were probably made following it, not only in their homeland in the Valley of Mexico but in Cempoala, Monte Alban V, upper Cerro de las Mesas, and in the Panuco period in northern Veracruz, to say nothing of the late Venta Salada subphase in Tehuacan. One sherd of a rather unique type, Mixteca polychrome, was found in a very late Venta Salada component. This type is diagnostic of Monte Alban V, where it may have originated, and that phase is dated A.D. 1200±100, A.D. 1380±100, and A.D. 1580±100 (Table 9, nos. 216-218).

Tancol polychrome links Tehuacan to the Panuco phase (Ekholm's Period VI) in the Tampico-Panuco region, where it appears to have originated. This type spread south to Cempoala III and IV and perhaps to Upper Cerro de las Mesas and the late level in which it was found at Tehuacan. This type along with Huasteca Black-on-white spread north of Tampico into the Los Angeles and San Lorenzo phases of Tamaulipas, which have been dated between A.D. 1200 and 1500.

Summary

We have integrated the chronometric and archaeological data in the Tehuacan Valley in order to produce a chronology for prehistoric cultural development which is as accurate as the data permits. We have attempted to correlate this chronology and data from Mesoamerica so to provide a final scheme in which all the archaeological components appear in an acceptable area-wide chronology. We recognize that, as the scope of the analysis and correlation expands, the possibility of error increases and so we have applied all proper checks.

The basis for dating the components of the Tehuacan sequence are the radiocarbon determinations. It was possible to utilize 84 samples to provide dates for 48 of the 57 components. At the time of this research (1961-1964) this was the largest number of radiocarbon dates which had been applied to a single regional sequence. What is more, the span of time involved was about 8,000 years; that is, from 6725 B.C. to A.D. 1275. The radiocarbon chronology is notable because of the continuity of the dates. Given a two sigma error, gaps between the dates are negligible. We have applied rigorously a one sigma error and find the largest gap between dates in sequential dated components ranges from 564 to 1092 years. This appears between Zones L and K of Purron Cave (2750±136 B.C. and 1925±131 B.C.). Most of the gaps are much less, averaging about 150 years. The obvious usefulness of radiocarbon dating is further confirmed by the agreement between the chronology and the alignment of 139 excavated components which was done by using stratigraphy, typology, and seriation. The whole body of data enabled us to provide rough temporal estimates for the remaining 91 components.

The radiocarbon or directly dated chronology in the Tehuacan Valley was checked and augmented by recognizing foreign items in components and tracing them to their origin where either the radiocarbon or relative age was known, a technique called "cross dating." This was not of great use in dating the preceramic components because foreign or trade items were rare or even absent. The technique was very useful in determining dates on 46 of the 67 components which included ceramics and it permitted close estimates of age or confirmed dates on 27 of the 31 ceramic components which had been dated by radiocarbon. An analysis of the results of applying these methods to the data shows that it has been possible to date with considerable confidence all but the first phase of the Tehuacan sequence.

Using the Tehuacan chronology as a base, it has been possible to expand it to include all of Mesoamerica, especially those phases which include ceramics. There was an abundance of identified ceramic material which permitted extensive and very frequently direct cross dating of components. Radiocarbon dates from components outside of Tehuacan varied greatly and for various carefully considered reasons we found almost 300 of them to be unacceptable. In utilizing about 200 compatible dates on archaeological materials which could be closely related to materials from Tehuacan we have expanded the Tehuacan chronology to include ten regional sequences. This chronology is a firm foundation upon which to base the consideration of the rise of civilization in Mesoamerica.

In aligning the myriad of components which can be grouped into the many subphases of culture in Mesoamerica, it is possible to see the manner in which human life developed and spread throughout the area. To be sure, many of the details are as yet unknown or unclear, but an outline commencing before 8000 B.C. and ending with the Spanish Conquest can be constructed. Nomadic Hunting, a life style which was in vogue before 5000 B.C., was gradually superseded by an existence characterized by a seasonal mobility and which saw the beginnings of agriculture. Pottery appeared in the Tehuacan Valley shortly after 2600 B.C. and the development of village life was well underway in the valley by about 1500 B.C. Parallel developments, as yet incompletely documented, took place in other parts of Mesoamerica. The nearly three millenia following the establishment of village life saw the rise of urban communities eventually developing highly organized social, economic, political, and religious institutions. These arose in different forms and at varying rates in the several regions of Mesoamerica. A chronological framework which can instill some order into the reconstruction of this complicated process has been put forward here. It remains to fill in the details.

REFERENCES

Andrews, 1965.
Arnold and Libby, 1950.
Ascher and Ascher, 1963.
Aveleyra A. de Anda, 1956, 1962.
Berger, Graham, and Heizer, 1967.
Berger and Libby, 1966.
Bernal, 1965*a*, 1965*b*.
Borhegyi, 1965.
Brainerd, 1951.
Brush, 1965.
Clark, 1960.
Coe, M., 1965.
Coe, M., Diehl, and Stuiver, 1967.
Coe, W., and Stuckenrath, 1964.
Crane and Griffin, 1958.
Cruxent and Rouse, 1956.
Damon, 1968.
Damon, Long, and Gray, 1966.
de Vries, 1958.
Dixon, 1959.
Ferguson, 1968, 1970.
Flannery, 1967.
Ford, 1962.
Godwin, 1962.
Green and Lowe, 1967.
Heizer and Bennyhoff, 1958.
Johnson, 1951, 1965.
Johnson and Raup, 1947.
Johnson and Willis, 1970.
Keeling, 1961.
Kidder, Jennings, and Shook, 1946.
Kuzara, Mead, and Dixon, 1966.
Libby, 1955, 1963, 1965, 1967.
Lowe and Mason, 1965.
MacNeish, 1958, 1964a.
MacNeish, Nelken-Terner, and Johnson, 1967.
MacNeish and Peterson, 1962.
Malde and Irwin-Williams, 1967.
Mann, W., Marlow, and Hughes, 1961.
Millon, 1966.
Noguera, 1940.
Oakley, 1964.
Olsson, 1970.
Olsson and Karlén, 1963.
Olsson *et al.*, 1962.
Paddock, 1967.
Parsons, 1967.
Phillips and Willey, 1958.

Piña Chan, 1958.
Ralph, 1959.
Ralph, Michael, and Gruninger, 1965.
Ralph and Stuckenrath, 1960.
Reeves, 1965.
Robinson, 1951.
Rouse and Cruxent, 1957.
Satterthwaite and Ralph, 1960.
Smith, R., 1958.
Smith and Gifford, 1965.
Spaulding, 1958.
Strong, 1953.
Stuiver, 1961, 1970.
Stuiver and Suess, 1966.
Straus and Hunt, 1962.
Suess, 1961, 1965, 1970.
Tauber, 1970.
Taylor, 1956.
Tolstoy and Guénette, 1965.
Walton, Trautman, and Friend, 1961.
Willey, 1966.
Willis, Tauber, and Münnich, 1960.
Wormington, 1957.
Zeuner, 1946.

IRRIGATION

CHAPTER 2

The Hydraulic Approach to Pre-Spanish Mesoamerica

Karl A. Wittfogel

Can the study of large waterworks be a key to the history of mankind? This question was asked pioneeringly in the mid-nineteenth century by Karl Marx and Friedrich Engels. It was asked in a new form by Max Weber during the first two decades of the twentieth century. And it was asked during the 1920's and, with a new theoretical and practical focus, during the late 1950's. Historians, prehistorians, archaeologists, anthropologists, and other social scientists have all stressed the significance of the waterwork theory, frequently calling it "the theory of hydraulic society."

The designation "hydraulic society" was coined by me; and those who use it refer not infrequently to the work I have done in this field. Hence I am compelled when reviewing the use of the hydraulic concept to mention my name as it occurs in passages cited. I do so, however, with two qualifications which, I hope, will limit misunderstanding: (a) scholars who find the theory of hydraulic society meaningful have not always accepted it *in toto*; and (b) I do not accept as accurate all formulations of the theory ascribed to me.

Having said this much, and before discussing the hydraulic approach to pre-Spanish Mesoamerica, I shall report briefly on recent applications of the waterwork theory to various parts of the world. My examples are not meant to prove the validity of the hydraulic approach; this can be done only through the scientific testing of the pertinent concepts and data. But they may serve as an index of the productivity of this approach — an approach which has also attracted scholars who, for one reason or another, do not fully identify with the theory of hydraulic society.

E. R. Leach at first hesitated to class traditional Sinhalese society as hydraulic. But he found, after studying Ceylon's land tenure and kinship in greater detail, that "the classical Sinhalese kingdom was a striking and characteristic example of what Wittfogel has called 'hydraulic civilization' " (Leach 1959: 2; 1961: 16).

One could have expected the hydraulic interpretation of Egypt to find continuing support, but this has not been the case. It is well known that, before the twentieth century, Egypt was generally viewed as a classic representative of hydraulic society and despotism. It is less well known that, since the late nineteenth century, Egyptian intellectuals, in promoting the modernization of their country, have avoided discussing the concept of Oriental despotism. And it is little known that contemporary Egyptian scholars who are critical of recent developments in their country have strongly supported the hydraulic argument. Professor Anouar Abdel-Malek, who was forced in 1959 to leave Egypt and who himself does not accept certain tenets of my position, praises Ibrahim Amer as the author of the first adequate modern study of Egyptian history and society (see Amer 1958). This study, says Abdel-Malek, "familiarized Egypt with K. Wittfogel's theses about hydraulic society." In fact, these theses "constitute the center of Ibrahim Amer's book" (Abdel-Malek 1962: 59, 86).

In his political history of Vietnam, Joseph Buttinger emphasizes the crucial importance of "a complex system of dams, canals, and other hydraulic provisions" for the early formation and "the stability of Vietnamese social institutions" (Buttinger 1958: 42). He interprets these phenomena with reference to the theory of "Oriental" (hydraulic) society (*op cit.*, 122, 175, 185, 196).

In their widely used text, *East Asia. The Great Tradition*, Edwin O. Reischauer and John K. Fairbank begin their history of China's higher civilization, not with the Shang dynasty (ca. 1766 to 1122 or 1027 B.C.) as recent archaeological finds and the deciphered Shang inscription suggest, but with the Chou dynasty (1122 or 1027 to 221 B.C.). However, they reject the time-honored interpretation of Chou as "feudal," since Chou contains only "occasional semi-feudal elements." And they go on to assert that the rise of China's traditional society, with its two "main" strata (officials and taxpaying commoners) (Reischauer and Fairbank 1960: 97), is best explained by the "water-control or 'hydraulic' theory," which "fits in neatly with the myths about the culture hero Yü, the original controller of the flood waters of China" (*op cit.*, 48, 51).

Tibet has no impressive hydraulic record, but it was strongly shaped by the organizational and acquisitive institutions of China's hydraulic despotism. In a study published in 1959, Pedro Carrasco concluded that the controls over property and revenue and the government structure "all fit Tibet into Wittfogel's simple form of Oriental despotism" (Carrasco 1959: 207). According to my criteria, Tibet did indeed constitute a simple Oriental society. In terms of hydraulic density it is marginal, since the development of the country's agrohydraulic works was rudimentary (Wittfogel 1957*b*: 191).

Several scholars who took a fresh look at Africa have found the concept of hydraulic society helpful in identifying the structure of certain of Africa's monarchical absolutisms and some of its hydraulic tribes. George P. Murdock clearly perceived the hydraulic setting of Egypt's Oriental despotism, and he pointed to "a parallel form of political structure" in the monarchical absolutisms south of the Sahara — and this despite their lack of a hydraulic formation. "African despotism," he states, bears "striking resemblances to the Oriental despotisms analyzed by Wittfogel." He considers African despotism "much too similar to Oriental despotism to warrant its establishment as a distinct major type of political system" (Murdock 1959: 36). The African despotisms Murdock had in mind were marginal agro-despotic societies, since, as a rule, they did not have even rudimentary hydraulic works. Murdock notes that in contrast to Oriental despotism proper, African despotism favored a strong development of slave labor.

Milan Kalous analysed the institutions of the Benin Kingdom with categories taken from *Oriental Despotism*. He reached the conclusion that "in Wittfogel's terms, we may classify Benin as a 'Marginal 2 Oriental Society.' In accordance with Wittfogel's theories, it may have arisen due to a 'Compact 1 Core Hydraulic area' which in this case would be Egypt." (Kalous 1970:117)

Robert F. Gray has made a study of a cluster of "irrigation-based" villages in the Tanganyika area (1963). While his views on hydraulic despotism (which, not surprisingly, he found lacking in his Sonjo villages) are somewhat out of focus, he has the merit of introducing us to another variant of the hydraulic tribes.

In pointing out distinctions between hydraulic and non-hydraulic tribes, investigations of Pacific islands have been particularly rewarding, since the inhabitants are faced with a variety of water problems which they have solved in a variety of ways: hydraulic, quasi-hydraulic, and non-hydraulic. Marshall D. Sahlins has pinpointed these differences and their implications for societal structure in his comparative analysis of certain islands in the Polynesian complex (1958) and in his study of a single island in the Melanesian complex (1962). In the former he used key criteria of the hydraulic theory. In the latter he invoked this theory by name (Sahlins 1962: 44, 225, 287, 444).

In the Western hemisphere the hydraulic approach has been reinforced factually and conceptually. In the Andean area, the significance of extensive hydraulic and non-hydraulic irrigation works in Incan society has never been in doubt, and the presence of such works in pre-Inca days, is being acknowledged with increasing frequency, sometimes with and sometimes without reference to the problem of despotism or to "Wittfogel's 'hydraulic' theory." (See Willey 1953: 361; Bassadre 1956: 195; Metraux 1963: 24.)

With respect to the Rio Grande Pueblos in the southwestern United States, the benefits of the waterwork approach have, within the last decade, been strongly underscored by Edward P. Dozier (1961: 101; 1970). And recent archaeological efforts evaluating developments in the Hohokam area of Arizona have strikingly confirmed the usefulness of this approach. Here excavations undertaken by Emil Haury in 1964 have made it possible to date sizable irrigation works as far back as the beginning of the Christian era. Moreover, the connection of the Arizona sites and the hydraulic civilizations of ancient Mesoamerica, which Pedro Armillas considered obvious (Armillas 1948: 105), is now obvious indeed.

Julian Steward's pioneering developmental concepts deal particularly with "irrigation societies." Since 1949 he has included Mesoamerica among the "early agricultural civilizations" in which irrigation farming was practiced in an arid or semi-arid environment (Steward 1949: 7).

William T. Sanders and Barbara J. Price state that Armillas's article (1949) on systems of cultivation in Mesoamerica stimulated the formation of a veritable "theoretical school." The members of this school "have all stressed the importance of hydraulic agriculture in the evolution of the civilization of the Central Mexican area." (Sanders and Price 1968: 179). They did so, according to Sanders and Price, on the basis of investigations that dealt mostly with the Aztec period.

These two statements are significant for what they say and for what they do not say. Today, the scope of the researches in pre-Spanish Mesoamerica has increased in space and in time depth. And, while some members of the original hydraulic "school" are not convinced that the hydraulic approach illuminates conditions in their special fields of inquiry, new researches outside the Mexican core region on cultural phases prior to the Aztec period suggest the value of the hydraulic approach in large areas that previously seemed to be unfitted for it. This is apparent in the study of the Classic period in which Sanders's Teotihuacan project figures prominently; and it is perhaps still more apparent in the study of the pre-Classic period in which Richard S. MacNeish's Tehuacan team has achieved such trail-blazing results.

The Theory of Hydraulic Society — Neither New nor Simple

These developments demonstrate the interpretative potential of the theory of hydraulic society and underline the desirability of fully clarifying this theory and its applicability to ancient Mesoamerica. Since Marx was the first to formulate the theory of hydraulic ("Oriental") society, we cannot discuss it without carefully considering its Marxist elements. Furthermore, the hydraulic theory has been affected, and in some degree obscured, by certain sociohistorical views that V. Gordon Childe presented as Marxist and that have found their way into recent interpretations of ancient Mesoamerica. Whatever we may think of Childe's Marxism, his ideas on Oriental civilization have become part of the intellectual reality in which we are living today.

V. Gordon Childe became widely known among nonspecialists through two books published in 1936 and 1942 respectively. In them he sketched the early history of mankind with special reference to the "Oriental" societies of Egypt and Mesopotamia. Stressing his Marxist position, he assured his readers that the peculiarity of the development of these societies was due in the main to their water problems and governmental ways of solving them. In this matter Childe was substantially in line with his British fellow Marxists who, at this time, were eagerly reproducing Marx's waterwork thesis and some of his pertinent writings. There is no need to trace here the socio-ecological circumstances that led the British Marxists first to give a crude account of Marx's hydraulic views and then, since the latter part of World War II, to avoid them altogether (see Wittfogel 1957*b*: 406). Enough to mention that since the mid-'forties, Childe has ceased to stress the hydraulic interpretation of the East (an interpretation that for his Marxist friends was now taboo) while he continued to stress the concept of the "urban revolution" (which was not).

Students of hydraulic societies should be alerted to the changes in Childe's position and also to the selective way in which a follower of Childe's, Robert McC. Adams, cites both him and the leading Soviet Orientalist, I. M. Diakonoff. In his comparative study of ancient Mesopotamia and Mesoamerica Adams (1966) refers to only two of Childe's later writings — writings in which Childe withdraws from the hydraulic interpretation that he had previously stressed. And, while reproducing Diakonoff's discussion of the importance of nongovernmental property in ancient Mesopotamia, Adams omits mentioning Diakonoff's statements regarding the presence of strong hydraulic trends in Early Dynastic Sumer and, in fact, in "all periods of the history of Ancient Mesopotamia" (Diakonoff 1969: 178, 185).

To be sure, Diakonoff's attitude toward the hydraulic issue is ambivalent. Despite the above-mentioned hydraulic references, he does not acknowledge Asiatic society as a major societal order as did Marx. Diakonoff took this negative position in the 'fifties when he conducted the researches cited by Adams, and he remained equally negative in 1967 and 1968 when he edited *Ancient Mesopotamia*. The most recent articles in this collection of studies by Soviet Orientalists are dated 1965 but it includes bibliographical references dating to 1967. Omitting the "Asiatic" from his list of socio-economic formations, Diakonoff notes only two "antagonistic" pre-capitalist formations, the "slave" and the "feudal" (1969: 15), whereas Marx since 1853 identified three such formations — the "Asiatic," the "ancient," and the "feudal" (see Marx and Engels 1957-68 (13):9).

Imposed law (*"lex data"*) has been distinguished from law arrived at after deliberation (*"lex rogata"*) (see Wittfogel 1957*b*: 100). It is equally important to distinguish between *idea data* and *idea rogata*. While all imposed ideas and laws are not necessarily worse than those created under freer conditions (1) (cf. Notes, p. 77), we should be made aware of the difference, and this Adams has failed to do.

Obviously the theory of hydraulic society is neither new nor simple. And obviously also, its acceptance or rejection has been motivated, not only by rational and scientific considerations, but also, and very substantially, by their opposites.

Three Major Peculiarities of the Concept of Hydraulic Society

Today it is customary to speak of hydraulic (Oriental) society as having at least three major peculiarities: (a) the ecological setting, (b) the agro-managerial activities inspired by this setting, and (c) the emergence of a despotic state. It is important to keep all three of these peculiarities and their interrelations in mind if we hope to understand the numerous and significant variations in hydraulic society. And it is also important to remember that these peculiarities were not recognized simultaneously and that awareness, when it came for each, did not entail equal analytic incisiveness. The existence of a peculiarly formidable type of despotism was conceptualized as early as the middle of the first millennium B.C. by the Greeks who lived close to the great powers of the East, particularly Persia.

Attempts to give an ecological explanation of Asiatic despotism were also made early. But for two millennia, macro-analysts of human conditions did not go beyond the assertion that climate was the main cause of the peculiarities of "Asiatic" statecraft and psychology. Montesquieu, who stressed the importance of territorial size, still upheld the traditional climatological interpretation. It has only been since the second half of the eighteenth century that new schools of philosophers and economists have discussed the socio-historical importance of the hydraulic factor.

Some German philosophers, especially Herder and Hegel, modified the classical ecological interpretation of Oriental despotism by pointing to the significance of large river valleys. And classical economists, beginning with Adam Smith, placed man as producer at the center of history.

Smith recognized that in certain Eastern countries specific hydraulic methods were employed to promote agriculture: "The works constructed by the ancient sovereigns of Egypt for the proper distribution of the waters of the Nile were famous in antiquity . . . Those of the same kind which were constructed by the ancient sovereigns of Indostan, for the proper distribution of the waters of the Ganges as well as of many other rivers, though they have been less celebrated, seem to have been equally great. Both countries, accordingly . . . have been famous for their great fertility." Smith also noted that in China, Indostan, and several other countries of Asia these hydraulic activities involved the development of special types of public works, particularly "good roads and canals" (more often he said "navigable canals"), which were handled by the "department of the public police" of "the executive power." (Smith 1937: 646, 688, 689)

In these latter statements Smith loosely linked the Asian governments' concern with agriculture and commerce to the maintenance of such "public works" as roads and canals. His notion that in some Asian countries a special "department" was in charge of these public works is hardly more specific. Taken together these ideas carry the hydraulic concept to a new threshold — to a new threshold but no further. It was Marx and Engels who brought together the major features of the classical argument in their concept of a special "Asiatic" or "Oriental" (hydraulic) state and society.

Shall we reject all Marx's insights because we reject orthodox Marxism? A non-Marxist student who is interested in comparing ancient Asian and American civilizations and who knows Marx only as a founding father of "scientific socialism" may try to by-pass his hydraulic views. But the spread of Gordon Childe's ideas makes it difficult to do this. A Marxist student who is interested in comparing these civilizations may try to base his studies entirely on Marx's orthodox ideas. But this too may prove difficult, since Marx's writings contain not only his ideology-oriented "orthodox" views, but also a wealth of truth-oriented ideas that reproduce and develop the classical heritage of socio-historical thought (2).

Pioneering Insights Inconsistently Upheld

Marx made his crucial contribution to the classical concept of Asiatic society in two articles, "British Rule in India" and "The Future of British Rule in India," published in *The New York Daily Tribune* in the summer of 1853. In these articles Marx drew directly on Engels's "Asiatic" ideas, which he had solicited and which echoed Adam Smith's views which I have just cited and the arguments of another classical economist, Richard Jones. (Cf. Wittfogel 1957*b*; 372; 1960: 489; 1962: 1.) The decisive passage in Marx's first hydraulic article reads: "There have been in Asia, generally, from immemorial times, but three departments of Government: that of finance, or the plunder of the interior; that of War, or the plunder of the exterior; and, finally, the department of Public Works. Climate and territorial conditions, especially the vast tracts of desert extending from the Sahara through Arabia, Persia, India and Tartary, to the most elevated Asiatic highlands, constituted artificial irrigation by canals and waterworks the basis of Oriental agriculture. As in Egypt and India, inundations are used for fertilizing the soil of Mesopotamia, Persia, etc., advantage is taken of a high level for feeding irrigation canals. This prime necessity of an economical and common use of water, which in the Occident drove private enterprise to voluntary association as in Flanders and Italy, necessitated, in the Orient where civilization was too low and the territorial extent too vast to call into life voluntary association, the interference of the centralizing power of Government. Hence an economic function developed on all Asiatic Governments, the function of providing public works." (Marx 1853; cf. Marx and Engels 1957-68 (28):266).

Marx considered two "circumstances" characteristic of the Asiatic constellation. He described the Hindu first as "leaving, like all Oriental peoples, to the central government the care of the great public works, the prime condition of his agriculture and commerce," and second as "dispersed . . . over the surface of the country, and agglomerated in small centers by the domestic union of agriculture and manufacturing pursuits." The first circumstance was the Asiatic public works system which, according to Marx, served primarily the purpose of water control and thus gave the Asiatic states their peculiar (agro-managerial) function and (despotic) strength. The second was the so-called village system which, according to Marx, gave each of these small unions "their independent organization and distinct life" and ensured the perpetuation of the despotic order. These small village communities have "always been the solid foundation of Oriental despotism;" they have "transformed a self-developing social state into never changing natural destiny." (Marx 1853. Cf. in this connection Jones's geo-hydraulic argument (1831: 119) which, in substance and via Engels, found expression in Marx's first hydraulic article.) Engels's letter of June 6, 1853 echoes Jones's argument (Marx and Engels 1957-68(28): 259). This letter also contains references to a special type of public works in Oriental governments and to a department dealing with them.

Marx elaborated his 1853 arguments in the first extensive draft of his *magnum opus* (Marx 1939). In this draft, which was written in 1857 and 1858, he substantially elaborated his comparison of Asiatic and non-Asiatic societies. But he added little to his key hydraulic thesis, and he neglected the ecological aspect of the matter. Worse, from 1859 on he used formulations that definitely blurred some of the "Asiatic" concepts he had formulated clearly in 1853 and in 1857 and 1858.

In his programmatic theoretical statement of 1859, Marx referred to four major antagonistic orders (Asiatic, ancient, feudal, and bourgeois) as "progressive epochs of the socio-economic formation" (*progressive Epochen der oekonomischen Gesellschaftsformation*) (Marx and Engels 1957-68 (13): 9). A Hegelian might interpret this formulation as typological, but an unsophisticated reader would interprete it as sequential — as implying an uninterrupted and ameliorative advance from one historical stage to the next. In the latter sense, Marx's 1859 statement is ideologically and politically useful, since it encourages the belief that his followers are by historical necessity initiating a new stage in a unilinear and progressive development. But viewed scientifically, the statement is both ambiguous and misleading, since it obscures the fact that, according to Marx's own convictions, history involves not only progress but stagnation and regression. In his hydraulic arguments in *Das Kapital*, Vol. 1, Marx has given equally confusing formulations. (See Wittfogel 1957*b*: 380, 416.) These formulations must not make us forget his trail-blazing ideas on "Asiatic" societies, their geo-historical peculiarities, their agro-managerial despotism, their non-hydraulic derivatives (Russia), their proprietary modifications (China), and their degrading effect on the inhabitants of supposedly idyllic communal villages (India). Marx's conclusions concerning the "unchangeability" *(Unveraenderlichkeit)* of Asiatic societies and their inability to engage in "self-developing" action and social revolution give Montesquieu's *immutabilité* thesis a new and tragic quality (Marx 1853).

Marx's concept of a special Oriental (hydraulic) society blazed the trail for a better understanding of history and society. In view of this fact any attempt to smother his contribution for extraneous reasons deserves to be called "mean" — this was Marx's term for those who commit "the sin against science" (see Wittfogel 1957*b*: 387, 403). But, while saying this, it must not be forgotten that, compared with other pioneering students of Asiatic society and Oriental despotism, Marx was slow to recognize the significance of the Oriental theory for pre-Spanish America. The insights he gained in this respect came at the end of his life and, while they are important for the hydraulic argument, they remained virtually unknown until today; and Marx himself did not integrate them in his own Oriental position.

Early Macro-historical Notions about Despotism and Hydraulic Conditions in Mesoamerica

Montesquieu, the first major student of total power who juxtaposed Oriental despotism to other forms of government was perhaps also the first to link the ancient higher civilization of the Western hemisphere and the despotisms of Asia (3). Listing both Mexico and Peru among those countries whose people have lived under "political slavery," he noted that at the time of the Spanish Conquest both were "despotic empires." It was much more difficult for the Spaniards to subdue the "barbarian Indians" (*Indios bravos*) than it was to subdue these two "great empires" (Montesquieu 1958, vol. 2: 524, 530).

James Mill found "Asiatic" conditions not only in India but also in pre-Spanish Peru and Mexico. And while he was particularly impressed by the waterworks of "the ancient Indians" in Peru, he also mentioned the presence of such works in Mexico. Like many other commentators, he considered the chinampas outstanding. In a footnote to his discussion of "the works of irrigation" in India, Mill dwelt on the hydraulic skill of "the ancient (American) Indians" and praised particularly "the floating gardens and fields which were on the lake of Mexico" (1820 (2): 26).

William Prescott, who knew the early Spanish sources much better than did James Mill, provided more specific data on works of irrigation and flood control (by dikes) in the Mexican area at the time of the Conquest (1936: 79, 83, 156, 210, 264, 291, 509). By placing these data in a quasi-Oriental frame, Prescott opposed the early Spanish writers who, as he observed, were eager to equate Aztec society and the European institutions they were familiar with, especially the institutions of feudalism.

Marx, who knew James Mill's writings, including his *History of British India,* and who excerpted Prescott's books on Mexico and Peru, was surely aware of their hydraulic statements. However, from 1853 to 1880 he touched on hydraulic developments in the New World only lightly — (Marx 1939: 377, 717). He exhibited a much greater interest in them in the 192 pages of notes he made on Morgan's *Ancient Society* (1877) shortly before his death — notes that he intended to use in a book he planned to write on primitive society and that Engels, in his *The Origin of the Family, Private Property, and the State* (1884) did not use as fully as, according to his Preface, he had intended to do (Marx and Engels 1957-68 (21): 27).

In these notes Marx associated himself unqualifiedly with Morgan's idea that the great Eastern nations never established themselves on the level of "civilization," but instead, and despite their accomplishments, remained on the level of "Upper Barbarism," a level that involved social stratification — "systematic slavery" and aristocracy — and living in "walled cities." The "Village Indians" of the New World, i.e., the Pueblo Indians, Aztecs, and Incas, never reached the level of Upper Barbarism since they had no iron plows and did not practice "field agriculture"; however, they did rise above the level of Lower Barbarism to the level of Middle Barbarism because they improved their horticulture by the use of irrigation. This was particularly true of the Aztecs who had built outstanding waterworks of various kinds (4).

Marx reproduced these ideas much more fully than did Engels in his *Family* book (1884). However, his notes on Morgan remained unknown until the Marx-Engels-Lenin Institute in Moscow published them in Russian in 1941. Even so they remained virtually unknown for a number of years after World War II.

The General Concept of Hydraulic Society Upheld and Elaborated

In the spring of 1940 I gave a talk at a major university in eastern United States for a group of Orientalists about the character of Asiatic society. My audience, which included two anthropologists, listened with interest. But when I pointed to ancient Mesoamerica as a variant of an "Asiatic" waterwork society, the anthropologists, who were well versed in the culture history of ancient Mexico, looked at me, first incredulously, and then with scarcely hidden amusement. Their skepticism was entirely understandable. In the investigations they had been trained to make in pre-Spanish Mesoamerica, sizable waterworks seemed of small significance. The frame of reference they used led them to neglect early hydraulic trends in that area as surely as my theoretical development stimulated me to identify them in 1940.

I had launched upon the hydraulic trail in the first of my larger historical studies, *Geschichte der buergerlichen Gesellschaft* written in 1923, about a year before the revolutionary upsurge in Shanghai drew the attention of the Communist International to China. In it I followed Marx enthusiastically, though not altogether uncritically (5). I accepted his thesis of the existence of a special "Asiatic" societal order, of a special "Asiatic mode of production," and a special "despotic" state (Wittfogel 1924: 49, 100, 117, 121). Combining his hydraulic views and Max Weber's, I spoke of a "hydraulic bureaucratic state of officials" (*wasserbaubuerokratischen Beamtenstaat*) and a "bureaucratic despotic state," (*op. cit.*, 117, 118). I bulwarked my thesis with arguments I thought Marx should have made, but had not made.

In this context I introduced a concept which, in my opinion, followed logically from Marx's socio-economic premises — that in "Oriental" societies the functional bureaucracy was the ruling class. In a second book published in 1926 I used the term "ruling class" for the bureaucracy of Imperial China, citing Marx's equation of tax and rent in Asia and asserting that, under such conditions, the exploitation of the peasants was essentially accomplished by "the state," the emperor, and the officials (Wittfogel 1926: 25, 26).

I did not fully understand the theoretical or practical implications of what I then considered a Marxist argument. But I sensed the socio-historical importance of the issue (which subsequently became very clear and very explosive) when I kept insisting that the bureaucratic representatives of the hydraulically managerial state constituted a ruling class (6). I did not call them a "caste" as Marx had done occasionally and misleadingly (7). Nor did I call them a ruling "estate," as Max Weber had done inconsistently and confusingly (8). And I certainly did not call them a ruling "elite" — that is, I did not accept Pareto's concept of circulating groups of societal leaders, which was notably abstract when it was first presented and which later helped to hide the self-perpetuating quality of the representatives of total power (see Pareto 1963: (2): 1787; 1968) (9).

Accepting Marx's and Engels's view that the societies of classical antiquity had not progressed to a higher form of society but had in fact ended in a "blind alley" (Marx and Engels 1957-68 (21) : 145; Whittfogel 1924: 114) and accepting Marx's view concerning the self-perpetuation *(Unveraenderlichkeit)* of Asiatic societies, I could not subscribe to the concept of a unilinear and necessarily progressive historical development. Relying on Marx's concrete data regarding the different fates of his three major antagonistic pre-capitalist societies, and disregarding the seemingly unilinear intent of his 1859 statement, I rejected, in 1924, attempts to present the social development of mankind as "unilinear" (*einlinienhaft*) (Wittfogel 1924: 121).

I re-emphasized the different fates of these three major societal orders in an outline of world history published in 1932, the last year of the Weimar Republic (Wittfogel 1932: 597, 606, 712). I repeated this idea in my article, "The Theory of Oriental Society," in 1938. Steward cited this article when he stressed the formative role of irrigation for societal change in 1949; and he did so again in 1953 when he stressed the "multilinear" pattern of societal development (Steward 1949: 11; 1953: 315, 318).

Toward a Differentiated Theory of Hydraulic Society

When I first discussed these matters in the midtwenties, I was not conscious of the need for differentiation in Marx's skeleton concept of "Asiatic" society. I was satisfied to reproduce his concept, adding only a few points, which in my opinion were inherent in his position but could benefit by elaboration.

From 1926 on I concentrated on an analysis of China as representative of the economy and society of Asia, as Marx had concentrated on an analysis of England as representative of capitalist economy. I compared China and other Asiatic countries (Egypt, Mesopotamia, India) and the Asiatic pattern as a whole with non-Asiatic patterns, (1931*b*) as Marx had compared England with other capitalist countries (Holland, France, Germany) and the capitalist pattern as a whole with non-capitalist patterns of economy and society. In neither case were these comparisons undertaken as systematically as they were in Montesquieu's *Spirit of the Laws.* In my analysis I tried to identify significant diversities in the geology, meteorology, and hydrology of China, the ecologically-conditioned diversities of plant cultivation (rainfall and hydro- and hydraulic agriculture) and similarly conditioned diversities in communications and trade and in hydraulic and administrative political developments.

This differentiating approach necessitated recourse to more than one discipline. And while I then did not even dare to hope that I might participate in the type of interdisciplinary cooperation which today is being so productively utilized in the study of prehistoric Mesoamerica, I did draw systematically on a variety of disciplines, in accordance with the demands of German historiography. (see Bernheim 1908: 85), which, I may add, were but rarely satisfied. In the case of China, the differentiating approach was required also by the country's advance toward increasingly complex socioeconomic conditions. This development included the abandonment of communal land tenure, the emergence of diverse patterns of private property-based handicraft and proto-capitalist industry, the rise of an incipient "Asiatic" commercial and money-lending capitalism, and of new classes and sub-classes. In all these matters (and with respect to regional differentiations) I sought to combine macro-, meso-, and micro-analytic procedures in a multi-dimensional approach, which I consider a core prerequisite in all scientific work of this complexity. In the course of this study, I employed rarely-used analytic tools, most of which were rooted in classical socio-historical thought, and not a few of which were conceptualized by Marx (Wittfogel 1929: 500-522; 1932: 472-480). After several turbulent years on three continents that included on-the-spot work in China, I was able to present in 1938, in "The Theory of Oriental Society," the image of a diversified hydraulic world that differed greatly from the geo-historical concept of Oriental society established in the nineteenth century (Wittfogel 1938).

The earlier theory had implied that in Oriental societies such as India, irrigation agriculture based on government-managed public works prevailed throughout the country. This was not the case. Marx's generalizations fitted best the conditions of what I then called "concentrated" hydraulic societies. In the hydraulic world as a whole these were certainly a small minority. The differentiated theory of Oriental (hydraulic) society recognized a variety of "loose" types, among them China and India, a point I saw clearly in 1931, (Wittfogel 1931*b*: 296, 411-415) (10) and Mesoamerica, a point I still did not see in 1938.

Two methodological studies undertaken while I was writing *Economy and Society of China* outlined a typology of Asiatic societies. The "Asiatic" typology given in the second study, (written in 1930 and published in 1932) included Peru, Hohokam, and the cliff-dwellers. Ancient Mexico was mentioned, but not as a variant of Asiatic society (Wittfogel 1932: 466, 585, note 150). In *Economy and Society of China*, I concentrated completely on the higher Asiatic civilizations of the Old World, whose Chinese variant I analyzed with all the empirical and conceptual resources at my disposal. In a follow-up study in 1935 I conceptualized the development of Chinese society as I then saw it. Early China I considered a feudal society with an increasing hydraulic trend which, at first, led to the creation of a feudal variant of an irrigation society and, at the end of the Chou period, to the establishment of a full-fledged waterwork (Oriental) society (Wittfogel 1935: 35, 41, 48). Involved as I was with the Asian scene, I disregarded the hydraulic societies of pre-Spanish America, with the exception of the Inca empire (*op cit.*, 27). But my knowledge of China enabled me to identify significant regularities, such as the cycle of agro-political crises. My 1935 concept of this cycle, which became widely known as "the dynastic cycle," (11) actually rested on arguments I had first presented in 1927 (12). In both 1927 and 1935 I dealt essentially with the conditions of Imperial China where land was privately owned and trade played an important role. In 1938 I elaborated this concept, adding a sketch of agrarian and political crises in "simple" Oriental societies — that is, in Oriental societies in which land ownership was regulated (Wittfogel 1938: 102, 109). But, as already noted, I had not yet had time to re-examine the pre-Spanish Mesoamerican scene. I still classed ancient Mexico as an irrigation society of the Orientally "feudal" type comparable to Japan, and not as a "loose" hydraulic society comparable to China (Wittfogel 1938: 102).

First Attempts to Include Ancient Mesoamerica

Closer relations with American anthropologists who knew the Rio Grande Pueblos (13) now enabled me to present a much more adequate view of the Pueblo Indians and Hohokam. Increased familiarity with the early Spanish records resulted in new and qualitatively better insights regarding the peculiarities of ancient Mesoamerica. Aztec civilization now definitely emerged as a variant of the "loose" type of Oriental society.

In 1940 I worked on a manuscript tentatively entitled "Oriental Society." In this manuscript which served as the first draft of *Oriental Despotism* I extended my analysis of hydraulic society institutionally to the tribal level and geographically to Africa and parts of America that, except for the Incas, I had previously excluded from my list of hydraulic complexes or had mentioned only in passing (Wittfogel 1940: 23-24, 55). The African section dealt with the extinct Azanian civilization and several of the hydraulic tribes of Eastern Africa, especially the Suk and, in more detail, the Chagga. In the American section dealing with the extinct Hohokam civilization I cited A. L. Kroeber's idea that this civilization was probably influenced by Mexico, F. W. Hodge's description of the old irrigation system, and A. V. Kidder's conclusion that the Hohokam findings suggested "a sociological system involving strong differentiation between classes and masses." (Kidder 1924: 127) The "extraordinarily elaborate irrigation works" led Kidder to assume the existence of "a strong centralized form of government." In the chapter on the Incas and some of their predecessors I cited Julio G. Tello's idea of an archaic Andean epoch, which in Chavin was "propagated to the coast" and which "preceded the coastal cultures proper." (Tello 1930: 265, 278). In considering "Maya Theocracy," I analyzed the various types of Maya waterworks that made drinking water available during the dry season, a role of singular urgency under the singular geological conditions of the lowland of Yucatan. Another chapter dealt with the Aztecs and some of their contemporaries and predecessors.

In a table attached to the Maya chapter in which I distinguished various types of water supply and their use in the hydraulic centers of America, the Orient, Africa, and Hawaii, I placed the Maya type of waterworks within the general frame of Oriental constructions for water supply. I did this despite the fact that the public works of the Maya were concentrated on providing drinking water and not on irrigation or inundation (see Table 11).

TABLE 11
Types of Large-scale Waterworks in Pre-Industrial Agricultural Societies

	Direct Productive Function		Indirect Productive Function	Flood Protection, etc.
	Irrigation	Inundation	Provision of drinking water	
Rivers	*Mesopotamia *India (Ganges) *China *Parts of Central and South America (Cholula, Highland Peru)	*Egypt *Parts of India (Indus) *Coastal regions of Peru (Chimu, Nasca)		*North China
Rivulets, springs, gullies (forming centers of independent agricultural communities)	*Rio Grande Pueblos and Zuni (partially) *Eastern Africa *Hawaii	Hopi ‡Zuni (partially)	Hopi	
Lakes	†China *Central America			*Valley of Mexico
Reservoirs	‡Southern India †China		Maya	

NOTE: When this table was typed originally the Maya were inadvertently placed in the column headed "Inundation." My text showed clearly that I wanted to list the Maya under "Provision of drinking water" (Wittfogel 1940: 24; cf. Maya chapter). The necessary correction was made at the time and is shown in the table reproduced here.

*Role essential in shaping socio-economic development.

†Role limited or secondary.

‡Role doubtful.

This is how I saw the hydraulic world in 1940. Regarding Mexico I wrote: "Mexico has no important rivers. Its lakes, although larger in 1519 than today, were never more than waterwork centers in individual valleys of varying size. Separated by high mountain ridges, it was impossible to connect by canals the lakes around the city of Mexico with those of the eastern and southern economic centers. But in the north where the plateau was flatter, the construction of a long overland canal was never attempted. Obviously the natural water-supply, which barely sufficed for the regional irrigation system, was utterly incapable of filling canals on a 'national' scale.

"No natural Nile connected the various ecological centers of Mexico and no artificial Nile could be constructed as a substitute. In a certain way the situation resembled that of Japan save in one extremely significant respect. Japan's centrifugal irrigation valleys had no concentrated water-work nuclei, whereas the converging lake centers of Mexico demanded that their settled agriculturalists develop extensive public works to protect the fields as well as to irrigate them. No massive directing bureaucracy was needed in Japan, whereas in Central America the growth of dominating urban centers of an 'Oriental' order was stimulated by what seems to have been an inner necessity. This necessity is documented by the growth of numerous independent centers. These showed many significant diversities but at the same time, all of them exhibited distinctly bureaucratic and theocratic features." (Wittfogel 1940: 115, 116)

A footnote underlines the fact that I abandoned the "Japanese" (feudal) interpretation of ancient Mesoamerica which I had upheld during the first ten years of my effort to identify the institutional relations between the irrigation societies of America and those of the Old World: "The above analysis distinguished between the 'oriental feudalism' of Japan (feudalism on the basis of decentralized irrigation agriculture) on one side and the regionally centralized water-work societies of ancient Central America. Previously I classed old Mexico together with pre-industrial Japan (Wittfogel 1932: 587; 1938: 102). Further investigation has led me to the conclusion that the ancient Mexican society was substantially bureaucratic and oriental. Certain feudal tendencies which really existed remained secondary in character. They complicated rather than constituted the underlying order which in its economic and political foundations was alien to genuine feudalism." (Wittfogel 1940:115, 116)

Since 1940 I have viewed Mesoamerica as a "loose" hydraulic society. In the summer of 1942 when I visited Mexico and Yucatan, I discussed my idea with Paul Kirchhoff who was familiar with some of my earlier studies and who had used a Spanish translation of "The Theory of Oriental Society" in his seminar. In 1943, an article by Esther S. Goldfrank and me provided a differentiated analysis of the hydraulic tribes of New Mexico (Wittfogel and Goldfrank 1943: 20, note 21). In her article on Pueblo society and personality Goldfrank referred in a footnote to my "forthcoming publication, *Oriental Society in Asia and Ancient America*" (Goldfrank 1945: 534). In the text, she indicated the relation between Pueblo society and ancient Mexico and Peru: "In ancient Aztec Mexico and among the Inca of Peru (societies depending on large-scale water control) social strata were very marked. No doubt, some degree of mobility was possible in these autocratic states, but essentially it was the sons of nobles who achieved the leading positions in military and priestly affairs. The commoners cultivated their fields in the growing season, and, in the dormant months of the years, were liable to be called up for military or labor service. Pueblo society is culturally peripheral to these great 'Oriental' complexes, and, like them, it depends for survival upon water-control. Like them, also, it is theocratic." (*loc. cit.*)

Personal contacts with Pedro Carrasco (since 1945-46), and Paul Kirchhoff and Pedro Armillas (since 1947) have enabled me to benefit from their knowledge of ancient Mesoamerica and to familiarize them with my analytic and conceptual efforts in this field. I also enjoyed a continuing exchange of ideas with Julian Steward who, from 1946 to 1952, was in the Department of Anthropology at Columbia University.

Intellectual cross-fertilization? In the large this is indeed what was occurring. Leaving it to the historian of ideas to determine the details of this process, I am content to say here that, since 1948, the waterwork approach to the study of ancient Mesoamerica has been increasingly employed. Since then it has been increasingly argued that the civilization of pre-Spanish Mesoamerica differed qualitatively from those of Greek and Roman antiquity and of feudal Europe — and this primarily because of the important role of irrigation agriculture in the first area.

The scholars who arrived at this conclusion realized quickly that the water resources of ancient Mesoamerica were quite modest, and they tried to cope with this fact in their geo-historical interpretation. Armillas suggested in 1948 that this limitation favored "cantonalism, making each valley self-sufficient in nearly all its economic products." (Armillas 1948: 107)

To be sure, the problems of a waterwork society go far beyond regional economic self-sufficiency and the possibilities for large-scale (and small-scale) irrigation. Recognition of this fact stimulated the acceptance of the concept of "hydraulic society" (which spread quickly) and of the distinction between "compact" and "loose" patterns of hydraulic density (which spread more slowly).

Sanders and Price's *Mesoamerica* (1968) is indicative of the progress that has been made in these respects. In discussing the water resources available for irrigation agriculture in classical Teotihuacan, they stress the coordinated action needed in handling these resources: the villages of Teotihuacan were all "served by a single permanent source of water"; hence "a highly centralized authority" was required to resolve the conflicts between "upstream and downstream cultivators."

Sanders and Price also found that the studies of the Aztec period undertaken by members of the hydraulic school "demonstrated conclusively the economic and integrative role of irrigation in the Central Plateau for that period." These studies "focused attention on the role of the Aztec states as entrepreneurs of hydraulic works." But their efforts did not result in the creation of a compact hydraulic society. Cognizant of the concepts of "compact" and "loose" hydraulic societies as I had formulated them in 1953, Sanders and Price concluded that "based on the relative amounts of irrigated versus non-irrigated land, a loose hydraulic society certainly existed in the area in 1519." (Sanders and Price 1968: 178-182 passim)

New Light on the Patterns of Hydraulic Society

The concept of a "loose" hydraulic society was developed in the course of the geo-historical study of China when it became clear that the original concept of Asiatic society could not cope with China's diversified conditions (see Wittfogel 1931*b*: 193, 424, 454; 1938: 110). With the advance of the comparative study of waterwork societies it becomes equally clear that the concept of a "loose" hydraulic society also fitted the conditions of Mesoamerica, whereas the earlier concept (Marx's desert-oriented and narrower concept) did not.

As in China, the water resources of ancient Mesoamerica were not spacially continuous. In both cases much of the agricultural land did not require extended irrigation works. And in both cases the hydraulic landscapes were agglomerations of ecologically diverse settings in which semi-aridity was much more frequent than full aridity (desert). However, while China and Mesoamerica are both considered "loose" hydraulic societies, they exhibit important differences in the dimension of their geo-agricultural units. Mesoamerica has no river basins of the magnitude and hydraulic potential of China's Great Plain, the Shensi lowlands, or the rice regions of the Yangtse River. These peculiarities of the Chinese landscape favored a much higher hydraulic density than was attainable in Mesoamerica, and they indicated that the two areas presented two variants of loose hydraulic society: China the sub-type "Loose 1"; ancient Mesoamerica the sub-type "Loose 2" (Wittfogel 1957*b:* 165).

Flood Control an Important Task of Agro-hydraulic Activity

In the study of waterwork societies, the concept "irrigation society" has been useful in emphasizing the importance of the productive aspects of water control, but it says nothing about the dimensions of the water-providing works (this deficiency stimulated the creation of the term "hydraulic"). And it obscures the protective aspect of the agro-managerial occupation with water (this deficiency suggested the formula "+prot." offered in *Oriental Despotism*).

Protective waterworks in hydraulic societies have developed unevenly. They have played virtually no role in hydraulic tribes, where even joint efforts were insufficient to ward off major floods. They have played only a minor role in state-centered hydraulic societies where there was no threat of extreme inundation. However, such a threat haunted several economic and political key regions of China and at least one such region in ancient Mesoamerica.

In China the excessive sedimentation in rivers flowing through loess deposits, among which the Huangho is the biggest (see Wittfogel 1931*b*: 30-43, 89, 203), has compelled settlers in the adjacent plains to build extended embankments since the dawn of history (Wittfogel 1957*a*: 345). In Mesoamerica large protective dikes apparently played a major role only in the Mexican lake area and at the close of the pre-Spanish period. In both cases the dikes gave a new dimension and quality to the density pattern of hydraulic society, the fight against heavy and disastrous floods requiring in traditional China, and still more spectacularly in Aztec Mexico, the mobilization of "much larger corvée teams than did the regional irrigation works." The higher hydraulic density that resulted from these developments may be indicated by the formulas, "L 1+prot." for China and "L 2+prot." for Aztec Mexico (Wittfogel 1957*b*: 166).

However, a number of the Aztec dikes that, as in China, were meant to provide protection against destructive floods, had another purpose not duplicated in China. These Aztec dikes were meant to separate the salt water that, because of excessive evaporation had accumulated in the lakes, from the sweet water that was to be used for drinking purposes and most particularly for irrigating the chinampa gardens.

It will be remembered that the chinampas became a major source of the food supply of the core area of Aztec power. After the establishment of the Aztec confederacy, to quote Armillas, "Tenochtitlan and Texcoco cooperated on the construction of 'alberados' or dikes which served the double purpose of preventing inundation and of separating the sweet from the salt water and thus permitting the extension of chinampa cultivation." (Armillas 1948: 109)

Although chinampa cultivation as such did not usually require large-scale cooperation, it did in the Xochimilco-Chalco area. Sanders and Price point to "state-controlled dikes" in this area "to control chinampa flooding." (1968: 177) And, according to Dr. Eva Hunt, in the Cuicatec region the distribution of the water that feeds "irrigation canals for the chinampas" is still a source of regional conflict today (see p. 199).

The Aztecs enriched the earlier (primarily productive) hydraulic systems of Mesoamerica by instituting protective methods that opened up new productive possibilities. But this greater potential did not alter the limitations imposed by the compartmentalized terrain (the control of the Aztecs over many of the territories they conquered remained brittle). It did, however, carry imperial power in Mesoamerica to a level that, to the best of our knowledge, had never been reached before.

Aztec Mexico shows that an impressive hydraulic society can emerge in an area where water resources are relatively modest. How did this happen? The comparative analysis of agrarian societies points to two factors favoring such a development: the institutionally and territorially expansive tendency of the hydraulic pattern of organization and the absence of effective societal opposition.

The Institutionally Expansive Tendency of the Hydraulic Pattern of Organization

All agrarian societies depend on the performance of a variety of activities for their perpetuation. These activities do not necessarily require the strict coordination and subordination (discipline) of its able-bodied members. For example, warfare has occurred in many organizational forms but "anarchic" patterns have characterized some of the most militant groups (Turney-High 1949: 66). Furthermore, neither in pre-classical or classical Greece nor in protofeudal or feudal Europe was unquestioning obedience a basic virtue (Wittfogel 1957*b*: 149). The implementation of laws does not necessarily involve a strict organization of the community, nor do religious activities, even when the supreme secular leader is believed to possess divine powers. Such a leader may be said to be theocratic, but this does not mean that he can impose an overall system of coordination and subordination on the members of his community.

The handling of relatively large amounts of water for the needs of an agrarian community presents fundamentally different organizational problems. It requires the coordination of a communal labor force and, above a certain magnitude, a leadership that directs the construction and maintenance of hydraulic installation and the distribution of irrigation water. These are continuing functions, and whatever the changes in emphasis and urgency, the resulting organizational set-up is also continuing. Those who control it tend to increase their power by applying integrated methods developed in the hydraulic sphere to non-hydraulic activities, some of which existed previously, such as warfare, and to others which came into being only with the growth of the hydraulic establishment: the general mobilization of manpower, without the restrictions inherent in feudal society; the development of a state post and intelligence department; the counting of people; the levying of taxes, again without the restrictions inherent in feudal society; and the building of large non-hydraulic structures (Wittfogel 1957*b*: 30, 50).

In several fields the relation between hydraulic and non-hydraulic patterns of organization has been fully recognized and discussed; in others, it has not been clearly identified. I am thinking particularly of the organization of warfare, which has received little comparative attention since Max Weber made his pioneering remarks about the difference between the military organization in hydraulic and non-hydraulic societies.

Weber, who concentrated on stratified societies, used as his major criterion the private and public ownership of the means of warfare in a professed parallel to a well-known economic concept of Marx: whether a fighting force is armed by a supreme commander *(Kriegsherr)* or whether each member provides his own weaponry constitutes a difference that is as socio-historically fundamental as the difference between the public and private ownership of the means of production. According to Weber, this difference was "in the Occident only the product of the modern age, whereas in Asia it was the starting-point of the historical development." In the course of his argument Weber also introduced two additional criteria: whether or not the prince monopolized military activities and whether or not he appointed the "officers." The rise of "Occidental towns," he noted, was coincident with the citizenry's organizing and equipping themselves militarily ("religious fraternization and self-arming"). Outside the Western world, and older than the rise of Occidental cities, there had been a different development, one in which "the army of the prince is older than the city."

Weber did not deny that self-arming was the rule in primitive societies; he simply did not deal with this subject. But within his chosen framework, the distinction he made between an authoritarian military organization and diverse other types remains pioneeringly suggestive. According to Weber, differences in military development were due to differences in societal development, which, in the final analysis, were due to one factor: "irrigation" or government "regulation of water." Indeed, it was the "regulation of the water" that aborted the "starting-points" *(ansaetze)* of self-governing towns with knightly or citizen armies. "Irrigation" involved "bureaucracy, the corvée of the subjects and the dependence of the subjects on the actions of the king's bureaucracy in their whole existence." It was "decisive in the cultural development of Egypt, the Near East, India, and China." (Weber 1923: 275)

Weber saw the nexus between governmental water control and coordinated and centralized military organization; but he did not, in his argument, consider the hydraulic tribes. Turney-High, in his *Primitive War,* recognized the correlation between "tribal cohesion and political authority" and a cohesive and disciplined military organization but he did not clearly recognize the integrative effect of government "regulation of water." He did come close to this insight when he placed "some of the pueblos of the Southwest" at the top of his authority scale and noted, for this area, the vital role of water, "rain," and rain-making ceremonies in the creation of communal authority (Turney-High 1949: 60, 68, 228, 244).

Weber's and Turney-High's arguments move in the same direction. They can help us clarify the military aspect of hydraulic societies. In many cases, these societies have been subdued by outside forces and although the members of such forces who actively participated in the fight for domination are usually quite ready to describe the kind of resistance they encountered, members of the subdued tribe or state themselves dislike discussing their previous military organization with outsiders, even when the latter are well-disposed. And militarily uninvolved outsiders, following the dictates of prudence or sympathy, often prefer discussing other subjects with their informants: folklore, religious ceremonies, subsistence, kinship, etc. (14).

Our information on the military organization of hydraulic societies is relatively meager, but the available data confirm Weber's military-hydraulic correlation. Gray notes that in the Sonjo villages the communal leaders who head the hydraulic system also dispose over a military group, the *batana*, although the *batana* are "not normally concerned with questions of irrigation or goat ownership." They are "a police force that is obedient to the ruling group and ready to enforce its orders." They are the core of the villagers' military organization and the "company leaders of the two warrior classes." In times of attack they defend their community, "reinforced by the other adult men of the village, all of whom possess weapons and are practiced in their use." (Gray 1963: 148, 150)

In the Pueblos of the Southwest and among the Chagga, hydraulic and military functions are linked not only through a joint directing leadership, an arrangement typical for many state-centered hydraulic societies, but also through an operational leadership, an arrangement that best fits primitive conditions. In the Pueblos the war chief is also the supreme disciplinarian in non-military matters; and it is often the war chief who oversees the communal work at the irrigation ditches (Wittfogel and Goldfrank 1943: 29). Among the Chagga, the hornblower originally mobilized the men for warfare; but when irrigation farming developed, he also mobilized them for the hydraulic and building corvées (Gutmann 1926: 373). Tightened internal control enabled the Chagga, on a much larger scale than the Sonjo, to fend off the Masai, the most feared warriors in the area.

The available accounts on Hawaiian warfare show that the native rulers, who had special officials organizing their subjects for hydraulic and other mass labor, also had special officials directing quasi-military units to enforce their power internally and to organize the mass of the population for war against other Hawaiian states. The student of Far Eastern institutions who remembers that, since the dawn of history, the Chinese had coordinated armies with a center and a left and right wing, may be interested to learn that the ancient Hawaiians employed a similar pattern in organizing their fighting men. William Ellis, who visited the Islands when the old order was greatly weakened but still extant, reports: "When about to engage in an open plain, their army, drawn up for battle, consisted of a center and wings." (Ellis 1826: 124)

The Spaniards who invaded Mesoamerica had horses and guns, both of which were unknown to the Aztecs. Although these new aids to war seriously disrupted the Aztec defense, the conquerors soon recognized that they were dealing with an army that had definite patterns of planning and organization. The accounts given by Cortez, Bernal Diaz *et al.* suggest, as do those presented subsequently, and mostly by civilians, (Prescott 1936: 30; Cortés 1942; Sahagun 1938, Vol. 2: 310, 315) that the hydraulic military correlation Max Weber postulated is valid not only for the Old World. In this as in many other aspects, the Aztecs were as close to the great waterwork civilizations of Asia and Egypt as they were alien to Western (and Japanese) military organization before the rise of absolute political and military power.

Bandelier's description of the military organization of the Aztecs was greatly influenced by Morgan's false assumption that Aztec society was tribal. But his Morgan-inspired approach, which prevented him from recognizing the Orientally despotic character of this society, enabled him to reject the feudal interpretation of Aztec Mexico that Cortez and those who followed him had promoted. At the close of his study of Aztec land tenure, Bandelier, returning to this point, stated "that the principle and institution of feudality did not exist in aboriginal Mexico." (Bandelier 1877: 95; 1878: 448)

The spread of the coordination-subordination pattern of organization from hydraulic to non-hydraulic activities occurs in its purest form (15) in compact hydraulic societies in which the territory under hydraulic management virtually coincides with the land cultivated. But even in the most compact of all hydraulic complexes, Egypt, there are non-hydraulic economic elements (Wittfogel 1957*b*: 164). And in non-compact hydraulic societies, hydraulic operations cover only part of the arable land, much of which is cultivated by means of small-scale irrigation or rainfall farming.

As a rule, geo-economic diversity goes still further. Non-arable land is often interspersed among discontinuous regions usually constituting the outer zones of either compact or loose hydraulic areas. Circumstances permitting, these zones serve such non-agricultural economic pursuits as food-gathering, trapping, and hunting, and in the Old World, herding. In addition they may, particularly in the case of a border zone, serve purposes of defense.

The economic interrelation between the hydraulic and non-hydraulic sectors in these mixed situations (Wittfogel 1931*b*: 460, 473, 494) has been recently described as "symbiotic"; this is a helpful concept if concern for economic form does not result in disregard of institutional substance. It is important to realize that different types of economy may have different organizational and military and political potentials. And it is important to distinguish between power economy and subsistence economy. The socio-economic unit with the stronger power economy tends to get more than it gives, and it tends to increase its control over weaker units.

Under agro-managerial conditions, the hydraulic sector tends to extend its superior organizational pattern and its political power to non-hydraulic zones. Such spacial expansion occurs generally where the hydraulic core is compact, but where this is the case it may serve primarily military aims. Its impact is much more significant in hydraulic societies of the "loose 1" type, such as China and India. And it is highly significant in hydraulic societies of the "loose 2" type, such as Mesoamerica.

How far can such expansion go? Obviously as far as the agro-managerial center can carry it, or until this center faces a non-hydraulic societal force that can effectively arrest it.

Societal Divides and Checkerboards in the Old World

Competition between hydraulic and non-hydraulic societies has figured spectacularly in several parts of the globe. In the Old World a "societal divide" (Wittfogel 1957*b*: 204) separated Orientally despotic Persia from classical Greece, the Byzantine and Arab states from proto-feudal and feudal Italy and Spain, and Mongol and post-Mongol Russia from feudal and absolutist Europe. In the Far East, large bodies of water separated the hydraulic and single-centered society of China from the feudal and multi-centered society of Japan.

In some instances the competing societal forces were arranged roughly like squares on a checkerboard, (*op. cit.*, 191) each maintaining its own identity. In Western Asia, Greek city-states were interspersed between smaller and larger Orientally despotic complexes throughout the Homeric and classical periods, that is, until Alexander, having conquered the Persian Empire, initiated the expansion of Oriental despotism to the whole of the eastern Mediterranean area. (*op. cit.*, 207, 283)

Did checkerboards develop in the heartlands of the hydraulic world? It has been asserted that in these heartlands several societal forces have appeared that represented non-"Oriental" institutional trends; feudal governments resulting from a disintegration of Orientally despotic nations or empires (during certain phases in the history of Pharaonic Egypt and Imperial China); rich merchants who asserted their power in assemblies or independent guild cities (in Babylonia and Buddhist India); and military aristocracies (in prehistoric Sumer and post-Vedic India).

Those who make the first claim usually do not make an institutional analysis of Orientally despotic states. If they did, they would notice that these states differed greatly in size and that the smaller were often more despotic than the larger. As I have said elsewhere, "Pharaonic Egypt fell temporarily into a number of quasi-independent territories; and post-Tang China was even more seriously dismembered. But in both cases the new political units perpetuated despotic methods of statecraft, and the term, 'feudal', which may with a certain poetic license be applied to the relations between the weakened center and its larger sub-units, is completely inappropriate when used to designate sub-units which are nothing but detached and smaller replicas of the larger despotic model." (*op. cit.*, 311)

Merchant leaders who uphold the interest of the government (hydraulic or otherwise) against the interest of the merchants (guild-associated or otherwise) reflect the strength of the government and not the strength of the merchants. In hydraulic societies, as in feudal societies, merchants may be organized in guilds, but this does not make them politically strong or independent. The guilds of hydraulic societies carried out a number of professional tasks, as did those of feudal Europe. But the two types of organization differed radically in their socio-economic position and in the ways in which they carried out their tasks (Wittfogel 1931*b*: 573-596, 713-719; 1957*b*: 100, 124).

In saying this I do not completely exclude the possibility that in certain regions of the hydraulic world, important merchants and associations of merchants asserted their independence temporarily. But the historical evidence to date is negative. This fact warns against accepting such a claim without careful philological and institutional analysis.

The *akil tamgari* who headed the merchants in early Babylonia was a high fiscal official of the despotic state. And the assemblies in which merchants played a part were essentially judicial bodies dealing with communal matters. They did not control the government of the towns in which they functioned (Wittfogel 1957*b*: 269).

In a number of city-states of Buddhist India, the *setthi* may have been a "representative of the commercial community" (Fick 1920: 260); and on occasion he may have had a place "in the royal councils" (Basham 1959: 222). But he did not necessarily deal with guild affairs.

And the merchant guilds about which we have specific information manifestly did not exert independent power.

A. L. Basham depicts the merchants as the main representatives of the third major class (caste), the *vaisya*, in which petty merchants ranked low, and richer elements, according to Buddhist and Jaina scriptures, were "powerfully organized in guilds." These scriptures reflect the views of unorthodox outsiders; and pertinent information given in the famous collection of Buddhist tales, the *Jataka*, must be read with this in mind. Basham, who considers the *Jataka* an important socio-historical source and who for some regions considers the rich merchants of the Buddhist period "a true bourgeoisie," does not ascribe an unduly high position to the merchants generally as do E. W. Hopkins and Max Weber (Wittfogel 1957*b*: 123, 143, 286). The corporations they formed were only *ad hoc* corporations, and the guilds, which regulated the economic and social life of their members, were important essentially "in the evolution of the trade castes" (Basham 1959: 217).

According to Hopkins, a Buddhist legend indicates that the old city of Thana (near present-day Bombay) was temporarily "ruled by a strong merchant guild." (Hopkins 1902: 175) But close examination of this source shows that "the merchants in question, far from controlling the government of the city, did not even control its trade." (Wittfogel 1957*b*: 121, 266). T. W. Rhys-Davids, an acknowledged expert on the Buddhist period, states categorically: "There is . . . no instance as yet produced from early Buddhist documents pointing to any corporate organization of a guild or Hansa league." (Rhys-Davids 1950: 211)

There is, in fact, little evidence that anywhere in the heartlands of the hydraulic world independent merchants were able to establish and maintain independent guilds or guild cities. But there is considerable evidence that in the formative days of some hydraulic societies military aristocracies were able temporarily to uphold their interests despite the growing power of hydraulic chiefs and monarchs. In this connection, I mention particularly the Aryan military nobles, who, ruled by a not-too-powerful king, figured prominently in oligarchic assemblies (Wittfogel 1957*b*: 265). During the post-Vedic period the banks of the Ganges may well have been a "thick swampy jungle" (Basham 1959: 41), whose physical conquest posed many problems and involved strong, and uneven, institutional changes. In some of the lowland regions the new masters moved quickly toward a despotic centralization of power, whereas in others, the political authorities, although taking on new functions, for some time continued to operate under their old oligarchic form of government (Wittfogel 1957*b*: 265).

It is quite possible that in some parts of prehistoric Sumer a similar type of conquest also involved rule by a similar military aristocracy. But for Sumer no early checkerboard situation is clearly documented. Whatever the conditions of the formative periods may have been, the hydraulic development soon led to the establishment of a bureaucratized and despotic state. According to N. Kramer, power soon rested with "the court and temple administrators and intellectuals." (Kramer 1948: 162) According to T. Jacobsen, in each of the early Mesopotamian city-states "one individual, the ruler, united in his hands the chief political powers: legislative, judiciary, and executive." (Jacobsen 1943: 160) (Concerning the political position of the Assyrian merchant colonies that flourished in Capadocia during the earlier days of the second millenium B.C., see Wittfogel 1957*b*: 267.)

Absence of Societal Checkerboards in the New World

The study of societal divides and checkerboards in the Old World has deepened our understanding of the great hydraulic states of the Orient proper. It is essential for our understanding of the New World. The hydraulic zone of ancient Mesoamerica did not, like the hydraulic zone of the Old World, border on large areas that stimulated rainfall agriculture or the rise of multicentered civilizations. Consequently no societal divide of the East-West type emerged at the periphery of ancient Mesoamerica. And there were no societal checkerboards like those that developed in Western Asia during the days of classical Greece or in Italy and Spain during the Middle Ages.

The hydraulic heartlands of Mesoamerica were repeatedly the targets of invaders, the best known being the Aztecs. To judge from the available data these various invaders were originally nomads who engaged in hunting, gathering, fishing, and perhaps some farming, but not, like the great tribal conquerors of the Old World, in cattlebreeding (prior to the advent of the Spaniards, the Western hemisphere lacked animals suited to a herding economy).

Thus the ancient Mesoamerican invaders had a different economic starting point. Were they, for this reason, more or less likely to be impressed by the institutional set of the hydraulic civilizations they subdued? Again a glance at the Old World is useful. The aristocratic warriors who may have been the earliest masters of Sumer's incipient hydraulic society, whether or not they had been nomad outsiders, could not have been impressed by a strong hydraulic power structure, since there was no such power structure in the region at this time. Hence they were not stimulated to abandon their traditional oligarchic system of leadership. In the northwest of ancient India, agro-managerial centers existed in Happara and Mohenjo Daro up until the coming of the Aryans. But the charioteering invaders were obviously not attracted by these civilizations. They destroyed the cities in the Indus Valley and for centuries maintained a village-centered pluralistic way of life (Basham 1959: 27, 30).

After the establishment of mighty hydraulic civilizations in the eastern areas of the Old World, their cattle-breeding neighbors who became much more effective militarily, also became much more alive to the benefits that a ruling group could derive from the organizational methods of agro-managerial states. In fact, the Huns, Toba, Ch'i-tan, Mongols and Manchus, the Turks, and the Arabs were already employing some of these methods when they invaded the hydraulic world.

In pre-Spanish America, the Aztecs were already hydraulically oriented when they moved into the Mexican lake area. According to their own history as recorded in the Codex Boturini, they had temples before they began their long migration (Radin 1920: 33, Plate 1). And according to Orozco y Berra's interpretation of this Codex, they were engaged in irrigation farming by 700 A.D. when they were in the Tula region (Orozco y Berra 1938, vol. 3: 77).

The Aztecs, the latest pre-Spanish invaders of hydraulic Mesoamerica, had enjoyed the benefits of agro-managerial power far too much to weaken it when they became the supreme masters. Earlier invaders who may have wished to replace an incipient hydraulic power structure by a pluralistic order probably did not have the strength to do so. Traces of temporary interruptions of hydraulic power structures in ancient Mesoamerica may still come to light; and if convincing evidence of this kind is presented, our developmental image will have to be modified. But the data at hand suggest no such development in the hydraulic heartlands of this area.

Nor did internal economic and social differentiation accomplish in ancient Mesoamerica what it failed to accomplish in the hydraulic areas of the Old World. Symbiotic economic conditions did, of course, involve the exchange of goods (trade); but trade did not necessarily involve professional traders.

With the growth of hydraulic societies trade led to the regulation of markets by the agro-managerial authorities — on the tribal level with some restriction by clans or other residual community forces and on the state level without such restrictions (Wittfogel 1957*b*: 233, 236, 242). And professional traders were not necessarily independent. The hydraulic government might give some of its officials the task of engaging full-time in commercial transactions, as for example in Hawaii, among the Incas, and in Pharaonic Egypt; or it might, for this purpose, employ merchants part-time, leaving them free to work part-time for themselves. (Wittfogel 1957*b*: 245, 248, 250, 255). But under agro-managerial conditions, even the establishment of complete private enterprise did not mean socio-political independence or the possibility of creating powerful professional associations or guild cities.

The significance of Old World experiences for the evaluation of the socio-political position in ancient Mesoamerica is obvious. In the formative phase of irrigation-based agriculture, a limited water supply may well have led to a kind of hydraulic cantonalism. But coincident with it, there could be, and there generally was, an interregional economic symbiosis, especially when widely desired items were involved. Salt was such an item, and it is not surprising that, in the Tehuacan region, "salt hamlets" and "salt industrial sites" were already flourishing in the Palo Blanco phase (200 B.C.-A.D. 700) (MacNeish 1967: 306; 1970: 11). But while salt was economically important, those who traded in it and at times also produced it were not important in the power structure (Sahagun 1938, vol. 3: 67). They did not become powerful patricians and heads of quasi-autonomous salt towns, as was the case in certain localities of feudal Europe, for example, in the north German salt city, Lueneburg (Wittfogel 1924: 79). And they did not become so important economically that the government felt impelled to erect an elaborate bureaucratic structure to control their business, as was the case in China's complex hydraulic society. In an account of the Chinese salt business I indicated the huge profits the Imperial government derived from it (16).

On the basis of what we know, in ancient Mesoamerica large private salt enterprises of the Chinese type did not develop in the Mexican lake region, but what salt business there was was obviously under some control. The Spanish chroniclers listed the salt trade along with many other kinds of business activity as being carried on essentially through the markets; but they noted that from it Montezuma derived a large revenue, a "*gran renta.*" The King of Texcoco also derived a substantial revenue from it (Torquemada 1943, vol. 1: 167, 450). In Maya Yucatan, salt was one of the tribute items exacted by the "lords" who, in various ways, controlled the producers, mainly people of the locality who worked the salt beds communally (Landa 1938: 74, 80, 104; Roys 1943: 47, 53, 68; Tozzer 1941: 230). In the Cuicatec complex south of Tehuacan, those who traded salt in late Aztec days do not seem to have been more prominent than those who dealt in other commodities. The regional records of the period studied by Dr. Eva Hunt indicate that the traders were not members of the upper class, but, like the "bulk of the peasantry," they were "commoners" (see this volume, pp. 205, 212, Table 15).

Much more socially prominent were the gentlemen-merchants of the period. Among the Maya of Yucatan "the richest and most highly esteemed" men dwelt nearest the "lords" and priests (Landa 1938: 94). Did the relatives of the rulers and other nobles who, according to Roys (1943: 51), were engaged in substantial trade live among these rich and esteemed persons? We do not know. In any case these noble merchants must be classed as "bureaucratic capitalists," members of a special stratum of the agro-managerial hierarchy (Wittfogal 1957*b*: 255). They certainly ranked above the ordinary traders of the period and probably below the gentlemen-merchants of the metropolitan lake area, the "*pochteca*."

The *pochteca* constituted another variant of bureaucratic capitalists. The manner in which their sons were educated indicates that these merchants, as a group, belonged to the ruling class. While engaged as professionals in overland trade, they also acted as government spies, unofficial negotiators in matters of diplomacy, and tax collectors (*op. cit.*, 259). But the evidence we have does not suggest that the *pochteca* constituted even a starting-point for the development of an independent societal force in the hydraulic world in which they operated. Thus the hydraulic societies of ancient Mesoamerica had no relevant societal competition. And while ecologically and culturally they varied considerably, their primary institutions were strikingly similar.

Some Common Denominators in the Hydraulic Societies of the Old and the New World

The peoples of Mesoamerica who initiated and sustained these institutions had only limited supplies of water to draw on. But they learned how to manipulate them in a way that exhausted their organizational and operational potentials, and made it possible, other conditions being equal, to produce more food than the non-hydraulic agrarian civilizations (17).

They shared a population density with the hydraulic civilizations of the Old World which was generally higher than that attained in non-hydraulic civilizations (18). They also shared with them a capacity to mobilize manpower more comprehensively than did the non-hydraulic agrarian civilization. Like the hydraulic civilizations of the Old World, they erected large public structures long before they entered upon an urban way of life. The peculiar economic (food-producing) and socio-political (labor-controlling) capacities were spectacularly expressed in their monumental style and in the dimension of their religious and administrative centers. That the pyramids, temples, city walls, palaces, and tombs of the Orient were monumental has long been noted. But it is only recently that their "monumental style" has been interpreted as a function of the peculiar labor-mobilization potential of hydraulic society (Wittfogel 1957*b*: 43).

Conclusions

The social historian will do well to keep these common denominators of the Old and the New World in mind when he investigates the peculiarities of the macro-, meso-, and micro-hydraulic developments in Mesoamerica.

In speaking of micro-hydraulic patterns of political dominance, I envisage a hydraulically linked and spatially limited community of a number of households, a village or a small cluster of villages. Some hydraulic complexes in East Africa, some hydraulic islands in the Pacific, and the dispersed hydraulic villages in southwestern United States fall within this category, which helps us to identify the micro-hydraulic beginnings of meso- and macro-hydraulic power systems.

In speaking of meso-hydraulic patterns of political dominance, I envisage an agro-managerially conditioned power center that controls and coordinates one or a few supra-localities — a valley, a plain, or a cluster of valleys or plains, regions frequently occupied by persons sharing a common cultural tradition. The hydraulic city-states and territorial states of ancient Mesopotamia, China and India make us aware of both the limitations of this category and of the need to use it as the starting point for arriving at qualitatively and quantitatively more differentiated conclusions.

Several meso-hydraulic regions (usually more than two) may be controlled by a macro-hydraulic power center, which connects them by communicational devices rooted in hydraulic patterns of mass labor. There may be only one major communicational link: a single river harnessed by extended dikes (e.g., the Nile which unified Upper and Lower Egypt), or an extended canal, an "artificial Nile" as it were (e.g., the Imperial Canal, which joined the strategic core areas of North and Central China), or an extended highway, a "dry Nile" (e.g., the state roads of the Incas). Or else, and particularly in sprawling empires, the controlling power center may employ combinations of these devices, which all have one thing in common: they are all physical (objective) means of communications created or made effective through hydraulically conditioned mass labor.

The Aztecs exerted imperial power over a sizable area. And they derived their organizational strength from large-scale and multi-functional water control. But the Mesoamerican area did not possess a natural Nile. Nor did the existing water courses suffice for the creation of an artificial wet Nile. And the rugged territory did not favor the building of a system of highways similar to those constructed in the hydraulic zone of the Andean area. But while the Aztecs lacked these *constructional* means of inter-territorial communication they developed the *organizational* means for such communication, which in all just-mentioned cases accompanied the constructional enterprises. Depending on runners, the Aztecs maintained a government-managed system of quick transfer of persons and intelligence that greatly impressed their Spanish conquerors (Wittfogel 1957*b*: 53).

As I see it, "classical" Teotihuacan was meso-hydraulic. An effective agro-managerial system enabled its masters to establish enduring control over their own region and several neighboring ones.

The meso-hydraulic complex of Tehuacan spread less far. During its urban period it seems to have comprised a few power centers, none of them ecologically conducive to a spectacular concentration of population and agro-managerial might. The available water supply of Tehuacan was probably somewhat greater than that of Teotihuacan. But its territorial and supra-territorial ecology did not favor as great a territorial expansion as Teotihuacan.

Dr. Eva Hunt's analysis of sixteenth-century documents dealing with nearby Cuicatec reveals both the hydraulic limitations and possibilities of a region that is said to resemble Tehuacan (see this volume, pp. 213, 230). According to these documents, irrigation was not employed everywhere, but like a stone that starts an avalanche, the response to aridity and a sufficient water supply in certain localities initiated a hydraulic development conducive to the spread of agro-managerial institutions throughout the region (see this volume, p. 246).

For the study of conditions in the late period of pre-Spanish Mesoamerica, urban Tehuacan is highly instructive. But even more so is its pre-urban development. In fact, for the understanding of micro-hydraulic beginnings and for the transformation of micro-hydraulic patterns of power, settlement, and exchange, Tehuacan promises to be singularly rewarding.

Recent archaeological evidence presented by R. S. MacNeish indicates that Tehuacan has had a long proto-hydraulic and hydraulic history. This history begins with "hydro-horticultural" activities (MacNeish 1967: 306) and the emergence of micro-hydraulic communities (hamlets and villages) (MacNeish 1970: 11). Its advance is marked by the appearance of "true" irrigation (MacNeish 1967: 24), truncated pyramids, and a "monumental" dam (see this volume, p. 97) near the Purron cave.

The fact that the Purron dam was not noticed by archaeologists who, for a considerable time, had been working in this locality and had driven over it daily, suggests that it is not the only sizable early hydraulic installation in the region. And the fact that the dam has a rather sophisticated texture makes it certain that, far from having sprung full-blown from nothing, it is the son and quite probably the grandson of smaller dams whose history invites comparison with related construction elsewhere.

I understand that the Tehuacan discoveries are not our sole evidence for the birth and youthful development of a hydraulic society in ancient Mesoamerica. But I understand also that they do constitute the most uninterrupted evidence of such a development in this area (MacNeish 1964*b*). They underline the enormous possibilities of this kind of exploration — and not only in Mesoamerica. There is no reason why further light on the origins of hydraulic society should not come from other parts of the West (especially the Andean area) and beyond it, from inadequately examined hydraulic areas of the Old World.

All rights reserved by the author.

REFERENCES

Abdel-Malek, 1962.
Adams, 1966.
Amer, 1958.
Armillas, 1948, 1949.
Bandelier, 1877, 1878.
Basham, 1959.
Bassadre, 1956.
Beloch, 1886.
Bernheim, 1908.
Buttinger, 1958.
Carrasco, 1959.
Childe, 1936, 1942.
Cortés, 1942.
Diakonoff, 1969.
Dozier, 1961, 1970.
Durkheim, 1953.
Ellis, 1826.
Engels, 1884.
Fick, 1920.
Goldfrank, 1945.
Gray, 1963.
Gutmann, 1926.
Hegel, 1919.
Hopkins, 1902.
Jacobsen, 1943.
Jones, 1831.
Kalous, 1970.
Kidder, 1924.
Kramer, 1948.
Landa, 1938.
Lattimore, 1940.
Leach, 1959, 1961.
MacNeish, 1964*b*, 1967, 1970.
Mann, H., and Kanitkar, 1920.
Marx, 1853, 1890-94, 1939, 1941.
Marx and Engels, 1957-68.
Metraux, 1963.
Mill, 1820.
Montesquieu, 1958.
Morgan, 1877.
Murdock, 1959.
Orozco y Berra, 1938.
Palerm, 1954.
Pareto, 1963, 1968.
Prescott, 1936.
Radin, 1920.
Reischauer and Fairbank, 1960.
Rhys-Davids, 1950.
Rosenblat, 1945.
Roys, 1943.
Russel, 1958.
Sahagun, 1938.
Sahlins, 1958, 1962.
Sanders and Price, 1968.
Smith, A., 1937.
Steward, 1949, 1953.
Tello, 1930.
Torquemada, 1943 ed.
Tozzer, 1941.
Turney-High, 1949.
Wang Yü-ch'üan, 1937.
Weber, 1923.
Willey, 1953.
Wittfogel, 1924, 1926, 1927, 1929, 1931*a*, 1931*b*, 1932, 1935, 1938, 1940, 1956, 1957*a*, 1957*b*, 1958, 1960, 1962, 1971.
Wittfogel and Fêng Chia-shêng, 1949.
Wittfogel and Goldfrank, 1943.

NOTES

1. Hegel stressed the fact that under the despotism of the Roman empire, where all subjects were equal in their lack of political freedom, "private" law attained a great perfection (Hegel 1919, Vol. 8, Part 2: 716).

2. I do not, as is customary, employ the designation "classical Marxism" to connote the assemblage of ideas that Marx and Engels upheld after they became historical materialists, i.e., after 1845-46 when they wrote *The German Ideology*. Nor do I, as is customary, employ the designation "orthodox Marxism" to connote the orientation of followers of Marx and Engels who seek to uphold *in toto* the ideas of the founding fathers of "scientific socialism." For those who consider themselves orthodox Marxists, this latter designation has obvious advantages, but it hides the fact that Marx's thinking was influenced by two major factors: the urge for truth, which was strong, and the urge for power, which was stronger. Other factors that motivated the thinking of this Dostoevskian personality can also be identified; among them, his urge to display his erudition, which, in not a few instances, hampered his presentation. However, the first two urges were probably the strongest, and they certainly are the most relevant for an evaluation of his rich and complex ideas.

Marx's urge for truth led him to approach the socio-historical reality through experience-rooted rational analysis and with full recognition of Man's classical conceptual heritage. This combined approach has resulted in what I call the "classical" elements in Marx's writings. It is these elements that have had meaning for scholars such as Max Weber who was sufficiently discriminating to recognize their significance and sufficiently independent to use them, despite Marx's politically slanted frame of reference which, at certain crucial points, obscured and even perverted his insights. (See Wittfogel 1957*b*: 385, 387, 388.)

The synthesis of these often contradictory urges constitutes the "orthodox" Marxism that Marx himself created and that his orthodox followers, Kautsky, Plekhanov, and the young Lenin, sought to uphold. With the spread of this orthodox Marxism, there emerged a crudely simplified "vulgar" Marxism, which, in certain cases, led to a complete perversion of Marx's original thought. Paraphrasing one of Marx's favorite expressions, we may call this version of his ideas "*lumpen*" Marxism. It is this version that has become enormously influential during the last decades (Wittfogel 1957*b*: 389 passim).

3. Durkheim was certainly right when he asserted that, while Montesquieu seemed to be comparing different types of government, he was actually comparing different types of society (Durkheim 1953: 56).

4. *Re* social stratification in Upper Barbarism: see Morgan 1877, p. 549, and Marx 1941, p. 49 ("systematic slavery"); and Morgan 1877, p. 560, and Marx 1941, p. 56 (aristocracy). *Re* "walled cities" in Upper Barbarism: see Morgan 1877, pp. 32, 153, and 543. Marx disregarded the first two of these passages (the first occurs in a chapter from which he did not make excerpts), but he translated in full the third passage in which Morgan classified the settlements of the "Village Indians" as standing "between the stockaded villages of the Lower and the walled cities of the Upper Status (of Barbarism). There were no cities, in the proper sense of the term, in America when discovered" (see Marx 1941:46)—that is, the "middle" barbarians did not live in cities, but the "upper" barbarians did. *Re* irrigation canals and other waterworks in ancient Mesoamerica: see Morgan 1877, pp. 11, 12, 27, 33 (four types of waterworks, obviously referring to the Aztecs), pp. 191, 195, 196 (all three passages expressly dealing with the Aztecs), and pp. 201 and 544. (Cf. Marx 1941: 1, 27, 46, 118, 120, 123.)

Fourier used the concept "civilization" doctrinally, but not deceptively, in a narrow unilinear way. And Marx's and Engels's attempt to adjust Fourier's concept to their materialistic views from 1845-46 and, from 1853, to their newly established multilinear position was scientifically rational, whatever we may think of their classification of traditional India and China (and of contemporary Russia) as "barbarian." The manner in which Engels employed the term "civilization" in 1884 was intellectually unfortunate. The obfuscating effect of this usage became increasingly clear when the term was intertwined with new ideological and practical issues. (See Wittfogel 1957*b*, pp. 385, 397 f., and 410 f. with regard to Engels, Lenin, and Childe respectively.)

But while the recent history of the term "civilization" warns us against using it uncritically, it ought not to make us abandon its use in its original meaning—a higher development of the arts of life. There is no reason why, in this sense, and suspending an ultimate value judgment (see Wittfogel 1957*b*: 420), we should not speak of agrarian civilization, hydraulic civilization, Aztec or Chinese civilization, or for that matter of modern industrial and totalitarian civilization.

5. I accepted "almost completely" (*fast ganz*) Marx's development scheme of "Asiatic, ancient, feudal, and bourgeois" formations, "my only deviation from Marx" being the assumption that "possibly" there had also been a transitional feudal phase in the early days of "ancient and 'Asiatic' society" (Wittfogel 1924: 121). This hypothesis which was partly inspired by Eduard Meyer, Max Weber, and Richard Wilhelm, proved untenable. But my eagerness to follow the evidence as I then saw it shows that, although I was carrying a Communist party card, I was willing to deviate from Marx's historical views when I considered this scientifically mandatory.

6. In an article, "Hegel on China", published in *Unter dem Banner des Marxismus* in 1931, I restated this thesis (p. 356); and I upheld it in *Wirtschaft und Gesellschaft Chinas*, Leipzig 1931, pp. 501 and 730.

7. In *Das Kapital*, Vol. 1, Marx attached to a frequently cited hydraulic passage a note which pointed to "the need for calculating the movements of the Nile" as having created "Egypt's astronomy and with it the rule of the priest caste (*die Herrschaft der Priesterkaste*) as guide of agriculture" (Marx and Engels 1957-68 (23):537). This note, like the text to which it is attached, while suggestive, is ambiguous and in part misleading. Did the priests "rule" because they knew and employed astronomy? Or did another group handle agro-hydraulic and other secular operations? Were the priests a hereditary group—a "caste" in the full sense of the term? Did all representatives of the ruling establishment belong to a caste? And how were such matters handled in other "Oriental" countries? Marx was very clear when he wanted to be. Why then did he, on this issue (the issue of the ruling class of an economically managerial state), confuse more than clarify? (For a discussion of Marx's "sin against science" see Wittfogel 1957*b*: 382.)

8. According to Max Weber's economically functional definition of class and his data on the hydraulic and other tasks of the Chinese officials, he should have called this group not a caste but a class (see Wittfogel 1958, Vol. 3: 3).

9. The editor of Pareto's book on the elites reports as a matter of fact that in 1923, after Pareto's death, an Italian journal founded by Mussolini declared that "Pareto was not a fascist, but that he had contributed much to fascist thinking" (Pareto 1968: 2).

10. These passages stress the relatively low percentage of cultivated acreage under canal irrigation. If viewed in terms of the differentiated concept of "hydraulic activities," which includes big protective waterworks, the percentage would, of course, be considerably higher (see Wittfogel 1957*b*: 165).

11. See Wittfogel 1935: 53 (cf. Lattimore 1940: 535). Giving Lattimore the benefit of the doubt I suggest that it may have been a lapse of memory that led him, when describing the "typical cycle" in his book, to cite only Wang Yü-ch'üan's statement in his article, "The Rise of the Land Tax and the Fall of Dynasties" published in *Pacific Affairs* in 1937. Wang did indeed discuss the concept of the cycle, but he made it very clear who the author was: "The first analysis of the vicious cycle inherent in the Chinese economy and society is clearly formulated by Karl A. Wittfogel 'Foundations and Stages of Chinese Economic History' . . . p. 53." By 1940 Lattimore knew a number of my writings well, including "Foundations and Stages . . ." (see Lattimore 1940: 571). He was editor of *Pacific Affairs* when Wang's 1937 article was published.

12. See Wittfogel 1927, Vol. 57: 324. Theoretically this earlier formulation of the cycle is richer and, in my opinion, more stimulating. It is part of the sub-chapter, "Agrarian crises and their causes" (pp. 320-327) which is followed by the sub-chapter, "Forms in which the agrarian crisis is overcome" (pp. 327-330). My 1938 discussion of the dynastic cycle is more differentiated than the one I gave in 1935. Probably because it was printed in German, and not published in English until 1959, it has not received the attention that has been given to my 1935 formulation, the briefest of the three. In a fourth treatment of the issue I discussed the relation between economic and political crises in such conquest societies as Liao (Wittfogel and Fêng Chia-shêng 1949: 375).

13. In March 1940 I married the American anthropologist, Esther S. Goldfrank, who, first under the guidance of Franz Boas and Elsie Clews Parson and later independently, had been working in the Rio Grande Pueblos. The information she gave me about Pueblo life deepened my understanding of the written sources which I now studied with increased interest. It so happens that among her notes on the Isleta Indians which she made available to Dr. Parsons after her return from that Pueblo in the fall of 1924 there was an account of Isleta irrigation work and ceremony which was unusually specific. I reproduced a longish passage from it in my 1940 manuscript "Oriental Society."

14. Descriptions of systems of "Oriental" warfare made by insiders for insiders may be superior to accounts of warfare given by the military writers of ancient Greece or feudal Europe. In the Liao dynasty Chinese scribes prepared an eminently illuminating description of the military organization and strategy of a Chinese conquest dynasty, which foreshadowed the power machine Chinghis Khan and his successors used to spread Mongol rule throughout the heartlands of the Old World (see Wittfogel and Fêng Chia-shêng 1949: 505-570).

15. As it is used above, the phrase, "in its purest form," implies that the hydraulic concept I am presenting is not an "ideal type" of a fundamentally unknowable reality, as postulated by the Neo-Kantian, Max Weber. It is an ontological instrument for approaching the socio-historical reality which may never be completely known, but in essence is knowable.

16. Wittfogel 1931: 526-536. In September 1935 I had the opportunity to observe personally the way the government supervised a major center of salt production, the great salt lake in southern Shansi. The entire lake was fenced in by a high wall, which was patrolled by soldiers, so as to prevent any salt from leaving the site without having been properly taxed. An employee of one of the salt-producing firms assured me that out of a 900 dollar sale the government took 800 dollars.

17. Irrigation farming necessitates planting in rows, a system which permits loosening of the soil, weeding, etc. The use of these methods produces much higher yields per unit of land than does extensive farming which, by scattering the seed, rules out such operations. The advantages of intensive farming are so obvious that in partially irrigable areas cultivators applied these intensive methods also to non-irrigated crops. This is what happened in traditional China (Wittfogel 1931*b*: 303) and in India (Mann and Kanitkar 1920: 72), and in ancient Mesoamerica. The Aztec peasant was expected to irrigate his crops whenever possible. But in any case he was expected to make "beds" for his corn, pulverize the soil, and weed (Sahagun 1938, Vol. 3: 39). The Mayan peasant of Yucatan, who did not water his crops, weeded them as carefully as did the inhabitants of the highland regions in which irrigation farming was customary (Wittfogel 1956: 157-159).

18. For the underlying geo-demographic principle, see Wittfogel 1956, pp. 159 f. Beloch's study of the populations of the Roman empire indicated a much greater population density (3:1) in the (hydraulic) Eastern provinces than in the Western provinces in which irrigation was limited or altogether absent (Beloch 1886: 507). Russel, whose comprehensive analysis of ancient and medieval populations is in the great historical tradition, considers Beloch's study trail-blazing. Since its appearance, "no one has really improved upon his work." (Russel 1958: 7) Like Beloch, Russel fails to recognize the effect of irrigation farming on population density; and he lumps together several types of population growth that institutionally should be distinguished. Nevertheless he finds that the population rate was generally higher in the East than in the West, and this not only during the early days of the Roman empire, but also at the close of antiquity and during the Middle Ages. He is somewhat puzzled that during the heyday of the Eastern

caliphate, its capital, Bagdad, had ca. 300,000 inhabitants (*op. cit.*, 89) and the capital of the Western caliphate, Cordoba, between 981 and 1002, had over 950,000 inhabitants (*op. cit.*, 92). Viewed against these very sizable figures, Russel's figures for the major cities of feudal Europe are illuminating: 59,000 inhabitants for Paris in 1292; 54,747 for Florence in 1381; 17,850 and 34,971 for London in 1086 and 1377 respectively; 22,800 for Nürnberg in 1449; 17,881 for Lüebeck in 1460-61; 7,476 for Amsterdam in 1470; and 6,000 for Berlin in 1450 (*op. cit.*, 60). For the argument's sake, I give two figures that, in my opinion, are indicative of the geo-demographic trend in hydraulic America. According to Rosenblat's estimate, Cuzco had ca. 200,000 inhabitants and the city of Mexico ca. 300,000 at the time of the Conquest (Rosenblat 1945: 205; cf. Wittfogel 1956; 159; 1957*b*; 66, 215). For the correlation between centers of irrigation farming and centers of political power and military expansion at the end of the Aztec period, see Angel Palerm's trail-blazing study of this phenomenon. (Palerm 1954 passim. Cf. also Palerm's *Introducción a la Teoría Etnológica*, Mexico, 1967, pp. 268 ff.)

CHAPTER 3

Water Control Systems of the Tehuacan Valley

Richard B. Woodbury and James A. Neely

Support for this study of the prehistoric dams, canals, fields, terraces, and other water control systems of the Tehuacan Valley was provided by a grant from the National Science Foundation for the senior author's studies of pre-industrial water management in arid regions. Collaboration with the Tehuacan Archaeological-Botanical Project made it possible for us to share the full resources of the Project, and particularly the results of site surveys and chronological studies, without which we could not have reached the conclusions presented here. The field work was completed in 1964, parts of our report were written during the next three years, but rewriting was completed only following the availability of final chronological data in May 1968, based on seriation of the ceramic data from all the sites studied by the Project, including such of our farming and water control sites as provided sherds.

Our study has followed the traditional archaeological research pattern of deriving a sequence of events from the field data and relating them to associated circumstances, in an attempt to understand the changing interrelationships of man's social and technological patterns and his physical resources. We have skirted the various theoretical problems of the rise of Mesoamerican civilizations and the role of water management in this rise, not because we consider them unimportant, but because we consider them too important to be reviewed from the basis of our limited case history. The patterns of land use for the past three or four millennia in Mesoamerica are beginning to be more clearly understood and data are becoming available that should permit testing of some of the opinions and "conclusions" advanced in recent decades. The Tehuacan Valley can provide part of the evidence. We hope that archaeologists working elsewhere in Mesoamerica will be more alert than ever for further evidence of the beginnings and development of the techniques and systems by which water resources were manipulated with increasing skill for agricultural, domestic, and eventually industrial purposes.

The maps published here were drawn by Marcia P. Bakry, with the exception of that of the Xiquila aqueduct by G. Robert Lewis; both are on the staff of the Smithsonian Office of Anthropology. The majority of the photographs were taken by Neely, but those used in the mosaic of the Purron Dam are by Chris L. Moser, to whom we are grateful for permission to use them. The photographic illustrations owe a great deal to the skill and patience of the Photographic Laboratory of the Museum of Natural History, Smithsonian Institution, and we are grateful to its director, Jack Scott, and to his staff.

We found the aerial photographs of the Comisión del Papaloapan, which were on file in the office of the Tehuacan Project, an invaluable source of clues for planning our ground reconnaissance, and we were fortunate in securing the generous cooperation of the Department of Geography of the National University of Mexico in making enlargements for us from several of the original negatives.

For technical advice and assistance on the problems of fossil canals we thank Maurice E. Cooly and E. S. Davidson, of the U. S. Geological Survey, Tucson, Ari-

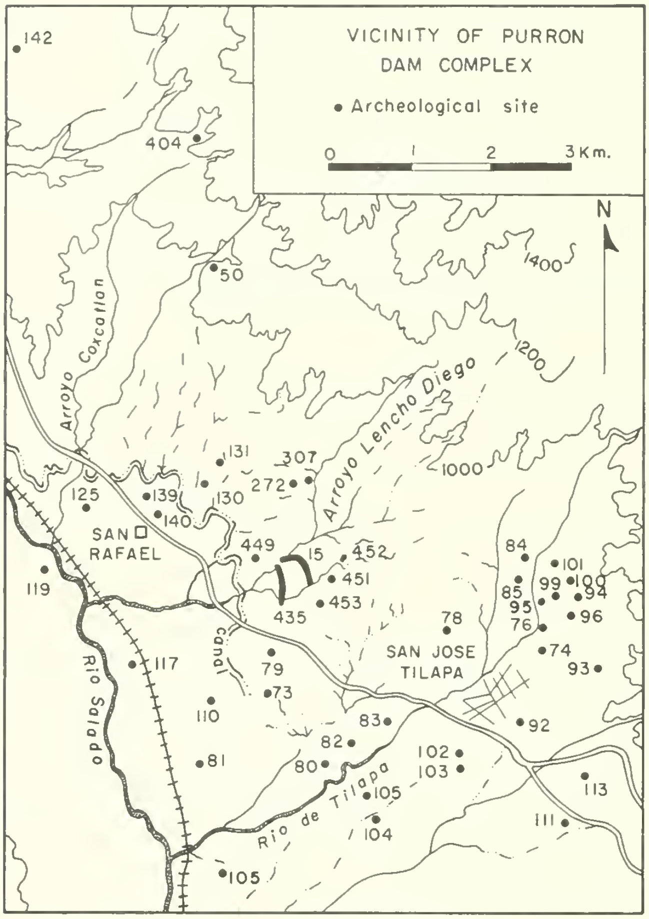


Fig. 5. Map of vicinity of Purron Dam complex.

zona, and Fernando Horcasitas P., who also provided valued bibilographic and linguistic assistance.

In the field we had the willing and valued assistance of Nathalie F. S. Woodbury and Mary Ann Neely, as well as the cooperation of the entire Tehuacan Project staff. Manuscript typing was by Anne M. Lewis and Jessie S. Shaw, of the Smithsonian Office of Anthropology.

It was our misfortune that we did not have an opportunity to see Eva Hunt's manuscript on her Cuicatec project before our manuscript was completed, although Neely had several productive conversations with her while he was in the field. Her work complements ours splendidly, and we regret that we could not have the benefit of her data to provide additional insights into the meaning and significance of our investigation.

A comment on chronology is in order: the absolute dates which we used in the preparation of our manuscript have required occasional adjustment in order to conform to the chronology employed elsewhere in these volumes; we are indebted to the editorial staff of the series for their care in cross-checking dates and correcting inconsistencies. These changes have not, of course, affected the relative dating of the agricultural and irrigation structures we discuss.

The Purron Dam Complex and Other Dams

One of the most interesting and spectacular water-control features encountered in the archaeological survey of the Tehuacan Valley is the Purron Dam complex. It is located in the southern portion of the valley in the area that is known locally as Mequitongo and that lies in the canyon of the Arroyo Lencho Diego, about two and a half kilometers northwest of the town of San José Tilapa (Fig. 5). Portions of the complex were discovered in 1961 in the initial site survey of the valley by the Tehuacan Archaeological-Botanical Project. In the preliminary catalogue of sites, however, the interrelationships of the components of the dam complex was not recognized, and each feature was given its own site number. It was not until excavations began in Purron and Abejas caves, located in the same canyon, that R. S. MacNeish realized that the massive walls of Tr 15 formed a damlike structure.

Our first visit to the Arroyo Lencho Diego confirmed his suspicions, as we found Tr 15 to be indeed some sort of dam structure spanning the canyon. Mapping and interpreting the features of the complex turned out to be more complicated than we had anticipated. Since the dense thorny growth prevented us from distinguishing features at distances even of five or ten meters, our preliminary survey was very slow. Much of the construction was also hidden by thick alluvial deposits. The preliminary topographic mapping of the region produced a perplexing plan that included three "dams," many platform mounds, and literally dozens of wall fragments exposed here and there by erosion.

Fortunately, the canyon's cycle of erosion has revealed details that have made possible much of our description and interpretation. Increasing familiarity with the area and the features, from several days of covering the ground and observing closely the cultural remains, made a basis for a reasonable reconstruction of the various building stages of the dam complex. The three dams first noted were reduced to two, and possibly only one; successive stages of construction were identified; the many platform mounds were seen in their proper perspective; and the majority of the separate "fragments" of construction found here and there were seen to be parts of the main dam's levels of construction or of the long, curved, damlike structure (Tr 15) upstream of the main dam. When the entire Purron Dam complex was finally understood, it was apparent that nearly 90 percent of its bulk remained, even though obscured and confused by extensive erosion and deposition during and after its use.

Since lack of time prevented detailed mapping or more than one small test excavation, this report presents only the results of our intensive survey. Additional data from excavation would undoubtedly modify many of our interpretations. But this brief survey does establish the actual presence of massive water-control features in the Formative period of highland Mexico, where their existence has long been assumed by a process of logical deduction (Millon 1954) but details of their form and function have been unknown.

The Arroyo Lencho Diego originates on the Cerro Chichiltepec, at an elevation of approximately 2000 m. above sea level. It extends some nine kilometers from source to mouth and descends the cerro in a southwesterly direction. The upper 6.5 km. of the arroyo is a small steep-sided canyon joined by small tributary canyons along its course, cutting through layers of slate and other metamorphic rocks that belong to the ancient structural core of the Sierra Mazateca (see Jean Brunet in volume 1 of this series). The vegetation in this part of the canyon consists of maguey, low thorny shrubs, several species of cactus, and occasional tree legumes. In the remaining 2.5 km. to its mouth, the canyon becomes much wider, up to about 1000 m., and its slope less acute. It lies between 950 and 850 m. above sea level. The topography changes in this lower portion to a broad flat-bottomed canyon with many narrow, steep-sided tributary canyons entering from all directions. A few small, round-topped hills are scattered here and there on the canyon floor. Deep alluvial deposits in this section are covered by shrubby vegetation, scattered patches of grass, dense thorn bushes, leguminous trees, and various cacti. The alluvial deposits have been cut, perhaps fairly recently, in a dendritic pattern, to a depth of 7 m. in some locations, by two large and many small intermittent drainage channels. Without modification, this area is suitable for horticultural exploitation primarily during the rainy season and for short excursions for limited hunting and plant collecting during the remaining months of the year. This broad portion of the canyon floor lies between barren, high rock cliffs of horizontally stratified beds of limestone, sandstone, and gypsum, through which the arroyo has cut its present bed.

It was in this setting (except for recent channel cutting) that the prehistoric inhabitants of the area constructed a complex of dams to provide irrigation for their extensive fields, which must have been situated on the large alluvial flats to the southwest. Today, the maps of the Comisión del Papaloapan show, between the ancient dam site and the Rio Salado, an area of cultivation of about 1.5 km. east-west and 4.5 km. north-south. Although some of the area is not farmed now, and perhaps for topographic reasons never could have been reached by irrigation water, an extensive area would still have been available for intensive cultivation. The main structure is strategically situated at a narrows within the canyon, 1 km. above its mouth and 900 m. downstream from the two rock shelters known as Abejas (Tc 307) and Purron (Tc 272) caves. The exact location chosen for the construction was perfectly situated from an engineer's viewpoint: the place where the broad portion of the canyon sharply constricts to less than half its previous width between two sheer cliffs 40 to 50 m. high. Below this point, the canyon again has a relatively constant width of about 400 m. for a distance of one kilometer southwest to its mouth. The broad floor of the canyon upstream from the dam, which formed the collecting basin or reservoir, and the narrower portion of the canyon running from the dam to its mouth, form a giant funnel draining into the large (1.5 by 4.5 km.) alluvial fan formed by the Arroyo Lencho Diego, by similar arroyos and canyons to the north and south, and by the east bank of the Rio Salado.

FIRST LEVEL OF CONSTRUCTION

The observation and interpretation of the various periods or levels of construction in the building of the Purron complex were made possible by the heavy subsequent erosion in the canyon. In addition to many small tributary erosional cuts, the canyon has two large intermittent drainage channels. The main channel (Arroyo Lencho Diego) originates at the head of the canyon, and runs below the northern wall, where the canyon widens into a broad, shallow basin and then courses southwest through the alluvial flats to drain into the Rio Salado. The second intermittent channel originates in the hills at the northeastern edge of the basin-like expanse of the canyon and flows along the base of its southern wall until joining the Arroyo Lencho Diego some 600 m. downstream (southwest) from the point where the canyon constricts and the dam was constructed.

Both channels have cut through the dam (Tr 435), one through its northern end and the other through the southern. However, it is the southern stream which has exposed the best profile of the huge dam, cutting through the structure in the area of its greatest width, to provide a cross-section some 100 m. wide by 18 m.

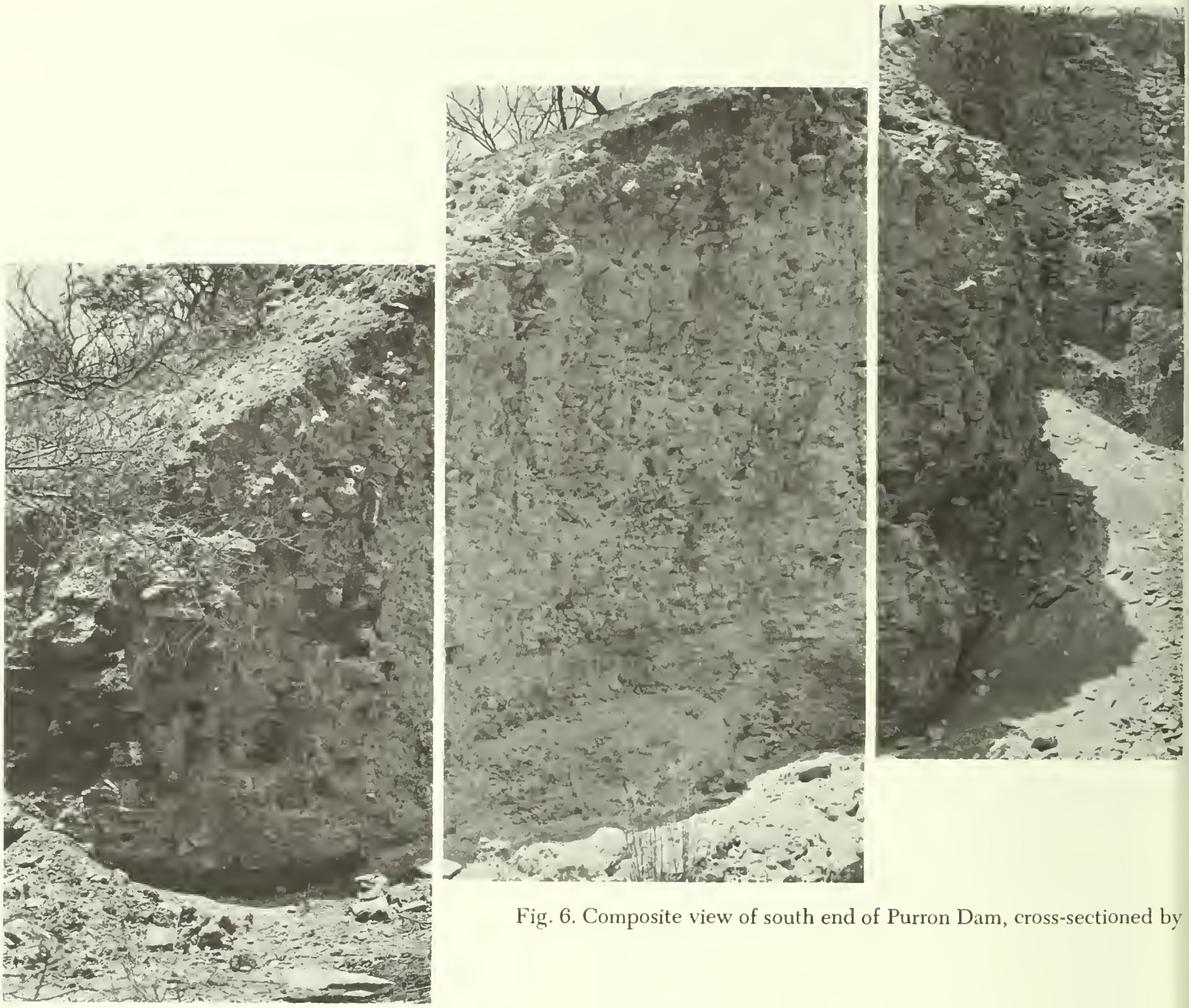
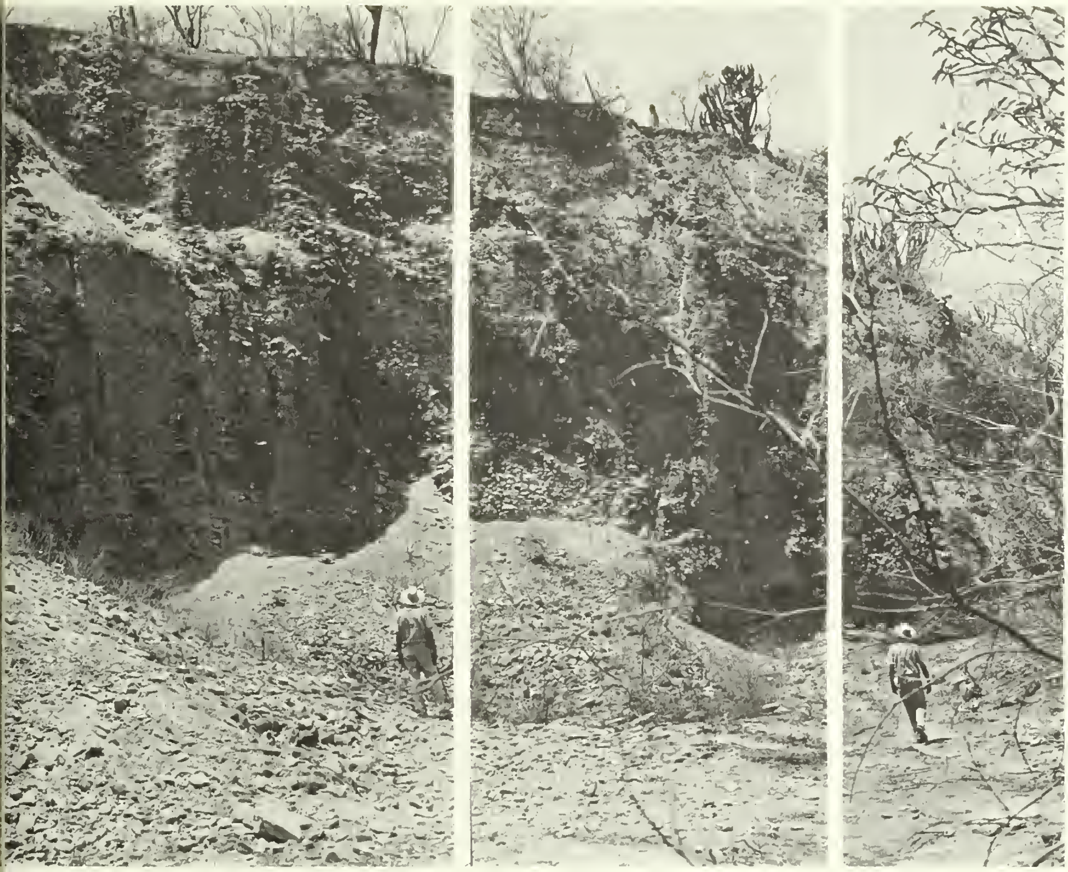


Fig. 6. Composite view of south end of Purron Dam, cross-sectioned by

high (Figs. 6, 7). It is from this profile that we have tentatively established four major levels and periods of construction and a fifth level of construction which appears to have been added after the dam had ceased to function (Fig. 8).

Evidence of the first construction was discovered in the western corner of the huge profile exposed by the southern stream. This early structure was dome-shaped in cross section, measured 6 m. wide and 2.8 m. high, and was primarily composed of earth and small stones laid over a foundation of large rocks. The eastern side was faced with unmodified dry-laid stones of small to medium size. It is possible that the western slope of the structure was also faced at one time, perhaps the stone being removed when the facing was laid for the second level of construction. Because of the small size of this dam as seen in profile, it quite likely did not extend completely across the 400-meter width of the canyon at this point. As the erosion of the canyon floor has been uneven, at this location the floor of the southern side of the canyon is about 10 m. lower than the surface of the ground at its northern wall. It is quite probably, then, that the first dam was only about 175 m. in length, extending a little less than half the distance across the canyon narrows. The northern and higher side of the canyon would, then, have not been dammed. Although we have no direct evidence of a spillway, it seems probably that some arrangement of a spillway and canals were present to drain the reservoir and take the water to the fields with a minimum of effort and loss of water.



ream action. (Photos courtesy of Chris L. Moser.)

The small size of the dam would indicate a type of spillway utilized in small dams and the larger canal systems built by the local farmers today — that is, a narrow slot cut through the dam closed off with large logs, boulders, and mud. Because of the sloping floor of the basin, lower at the south, the location of such a spillway in this early dam was probably at the southern end of the construction to permit complete or nearly complete drainage of the reservoir. Evidence of such a spillway is either hidden by fill or has been completely destroyed by the cutting of the present intermittent stream channel.

Because the dam was small, the resulting catch basin was also small, perhaps covering only an area of about 140 by 170 m., which is much smaller than the esti-

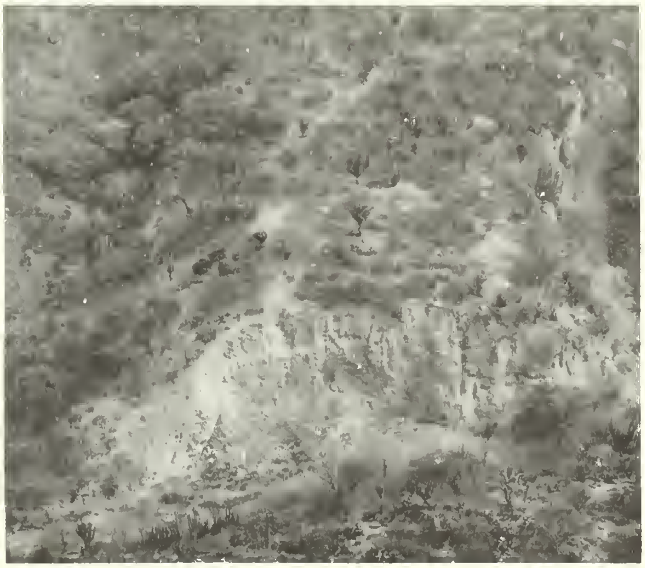


Fig. 7. Purron Dam, seen from the top of the cliff above its south end.

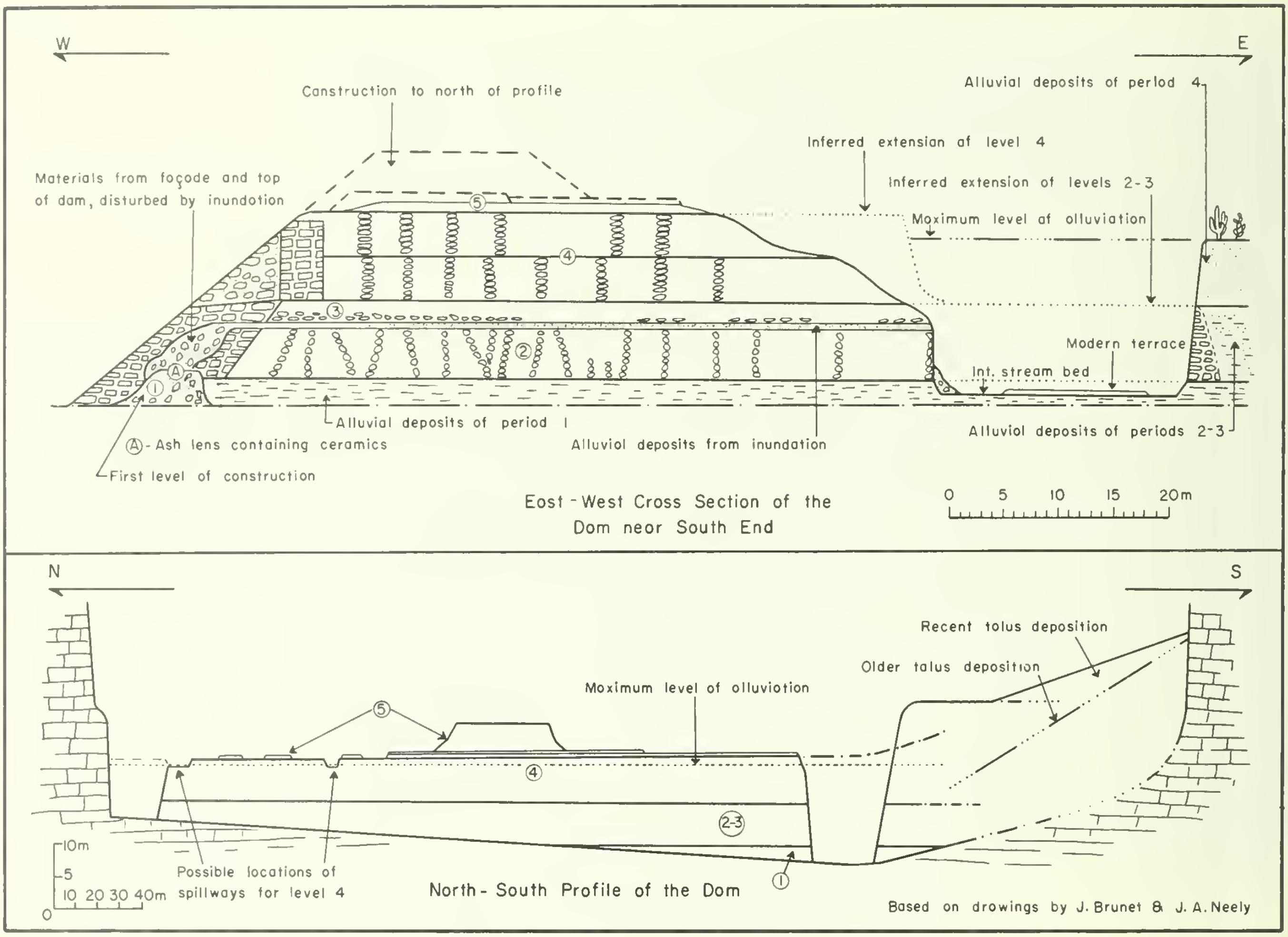

W
E
Construction to north of profile
Alluvial deposits of period 4
Inferred extension of level 4
Inferred extension of levels 2-3
Materials from façade and top of dam, disturbed by inundation
⑤
④
③
②
①
Ⓐ
Maximum level of alluviation
Modern terrace
Int. stream bed
Alluvial deposits of period 1
Ⓐ - Ash lens containing ceramics
Alluvial deposits from inundation
Alluvial deposits of periods 2-3
First level of construction
East - West Cross Section of the Dam near South End
0 5 10 15 20m
N
S
Recent talus deposition
Older talus deposition
Maximum level of alluviation
⑤
④
②-③
①
10m
5
10 20 30 40m
0
Possible locations of spillways for level 4
North - South Profile of the Dam
Based on drawings by J. Brunet & J. A. Neely

Fig. 8. Longitudinal and transverse sections of dam.

mated area of the reservoir in later periods of construction. The only stumbling block in the reconstruction proposed here is that neither the base nor the lateral extent of this early structure was observable. The dimensions and calculations presented are based only on the visible evidence of the dam's size as seen in the stream-cut profile.

Finely stratified layers of soil and small gravels were found behind (east of) this first dam. This silt and gravel, in fifteen to twenty horizontal layers of alluvial deposition, represents a period of some decades' use (Brunet, pers. commun.) before the basin silted nearly to the top of the dam, rendering it useless.

SECOND LEVEL OF CONSTRUCTION

The second level of construction was much more extensive than the first. It was at this time that the dam was built entirely across the canyon, some 400 m., and also probably reached its greatest width, about 100 m. As may be seen in Fig. 8, the second level of construction was built over the first, and generally speaking, the construction methods of this level and subsequent levels are basically the same as those used in the first dam. The mass of the dam is composed of tan sandy earth, a large quantity of fine gravel, and small angular rock fragments. In the second and subsequent construction levels, however, this fill is well compacted between rather crudely built retaining or reinforcing walls forming cubicle-like compartments within the dam. In the second level of construction these walls were of dry-laid, unmodified, water-worn cobbles, primarily of igneous rock, combined with a few slightly worked slabs of sedimentary or metamorphic origin. These walls range from 20 to 60 cm. in thickness and usually reach the entire height of the construction level (Fig. 10). They evidently served as temporary facings to retain the fill during construction and as permanent reinforcing for the level as a whole. The use of such internal construction and its variations is seen in large structures throughout Mesoamerica and Central Amer-

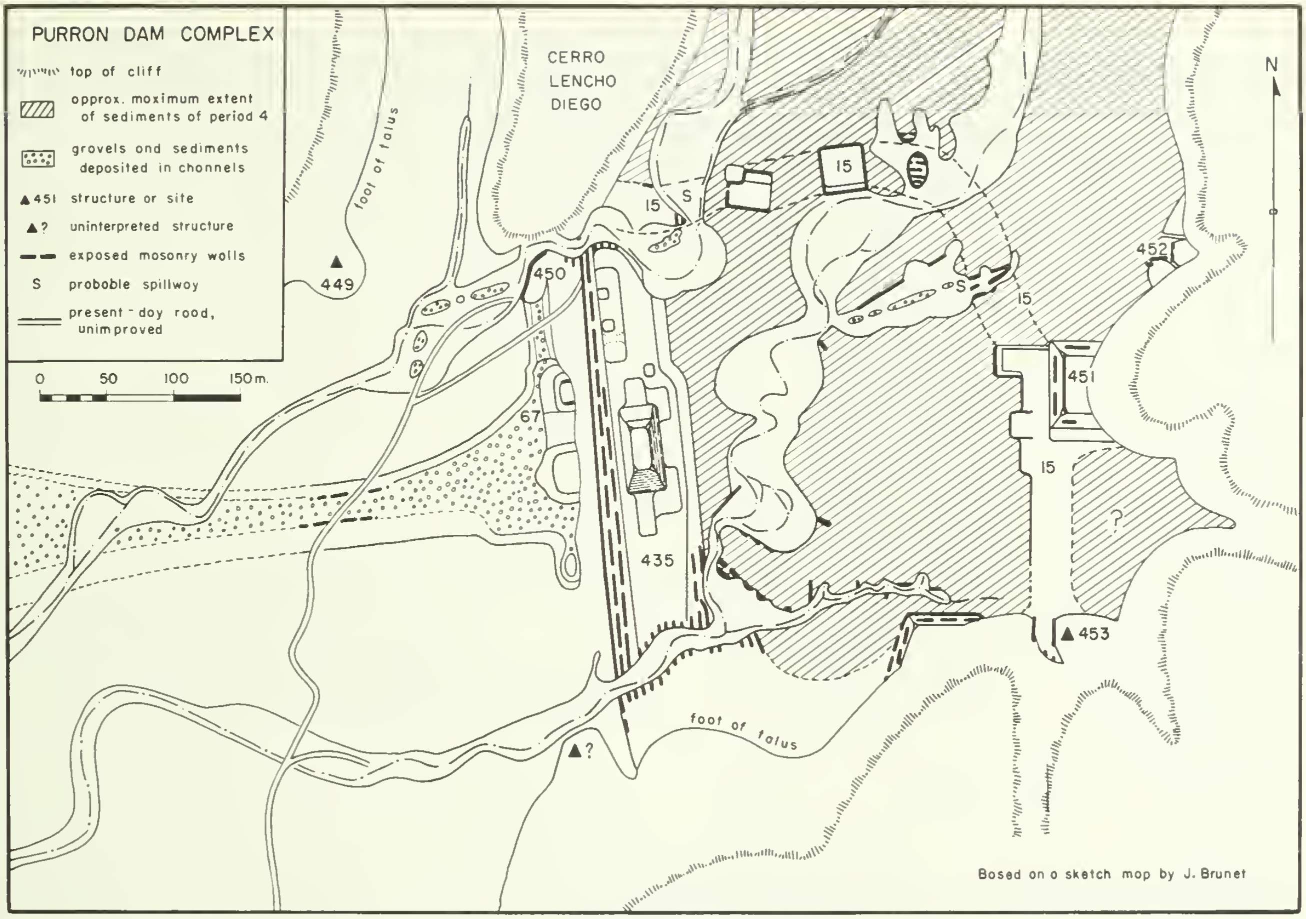


Fig. 9. Plan of Purron Dam, structure Tr 15, and associated structures, deposits, and channels.

ica (for example, see Woodbury and Trik 1953, fig. 10). This core of rubble fill within rock walls was then faced along both the upstream and downstream sides of the dam with roughly shaped rectangular slabs of rock, averaging about 30 to 40 cm. and 10 to 20 cm. in thickness, set into a clay mortar. Most of the slabs are of sedimentary rock with horizontally layered sandstone, limestone, and gypsum as natural constituents, enabling the prehistoric masons to split it along these lines of bedding with minimum effort and a relatively "finished" appearance.

There evidently was a period in which the dam was inundated briefly and a thin layer of alluvium deposited on Level 2. In this flooding it is quite likely that the top of the dam and any structures on it were damaged, as was the downstream or western face, the outside layers of which are in a jumbled, disturbed state in the profile (Fig. 8). It is, of course, possible that we have misinterpreted the profile at this level and that the disturbed nature of the face is merely fill thrown into the space occurring between two building levels. The first interpretation, however, takes into account not only the

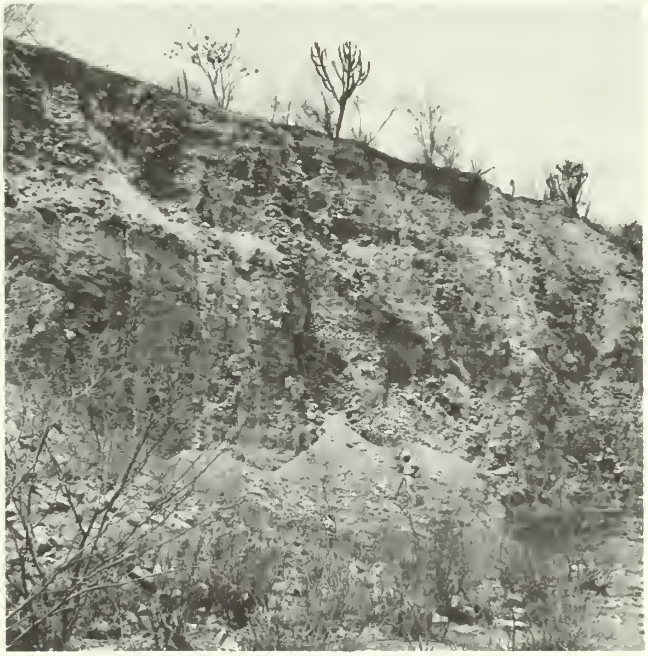


Fig. 10. The south end of Purron Dam, exposed by stream action, showing internal retaining walls in construction levels 2 and 4.

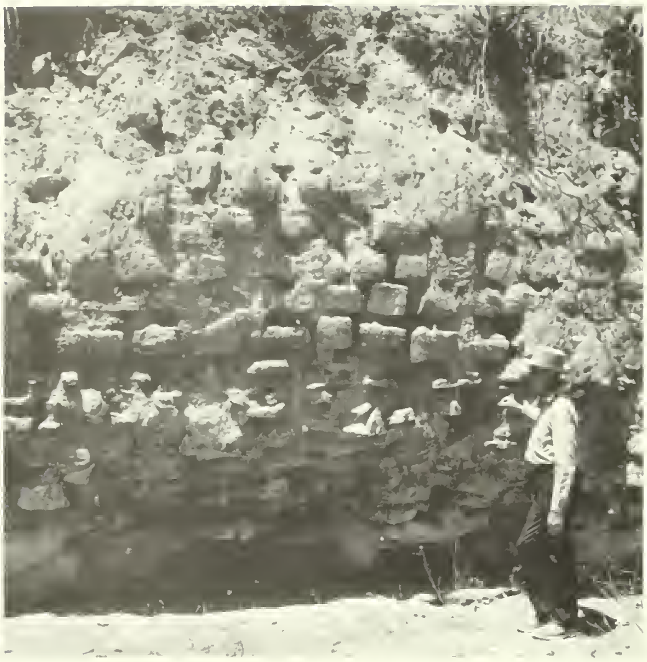


Fig. 11. Masonry of downstream (western) face of Tr 15, exposed and undercut by recent erosion.

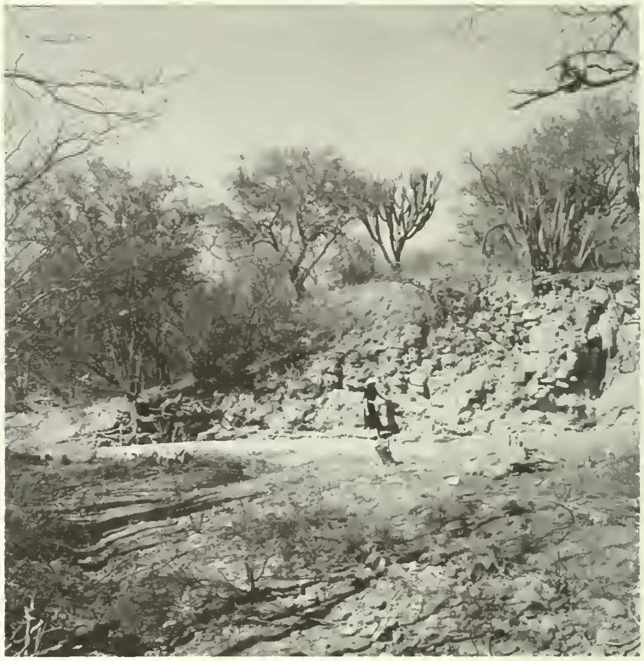


Fig. 12. Exposed cross section of Tr 15 near its west end.

disturbed area of the face, but also some 50 cm. of horizontally layered soils which certainly appear to be water-deposited silt. The fact that the flows in the canyons of this region have been known to rise suddenly from nothing to a depth of over 2 m. during flash floods, lends credence to the theory that such an inundation took place. Even careful excavation would probably never reveal the details of this apparent flooding. It may have been due merely to heavy rains or a flash flood at a time when the dam's reservoir was full. Or perhaps it resulted from failure to enlarge the dam when enough silt had accumulated to cause water to flow over after only an average season's rainfall.

During the second period of construction on the main dam, another large structure, Tr 15, was erected within the canyon. Tr 15 was built in a huge arc spanning the canyon upstream behind the main dam (Tr 435). Although some portions of the structure are completely buried beneath the alluvium, enough is visible above the deposited silts or is exposed by the erosion of the intermittent streams, to give a fairly clear picture of its construction. The over-all plan is a raised, flat-topped structure approximately 550 m. long, 30 m. wide and 3-5 m. high. Built in much the same manner as Level 2 of Tr 435, the structure consists of a core of earth and small stones between walls functioning as retaining and reinforcing elements. This core was then faced on both sides with slabs of non-local reddish-tan sandstone and some metamorphic and igneous rock (Fig. 11). These stones, which have been only slightly shaped, are approximately the same size as those used for facing Tr 435. As in the main dam, the stones were set into a reddish-brown adobe-like mortar 3-8 cm. thick. It is conceivable that the facing was covered with a layer of clay or lime plaster; however, no evidence of such a coating was found during our investigations.

The surface of this flat-topped structure served as the base for at least three groupings of platform mounds. On some of these may be seen the stone foundations of small, rectangular "houses" (averaging about 2 by 3 m.). These platform mounds appear to be of earth and rubble fill with a facing of slightly modified sedimentary stone. The survey revealed two breaks or "spillways" built into the structure, although it is quite possible that more existed and are now concealed by the thick alluvium covering most of the construction. The spillway visible near the west end has been beautifully sectioned on a diagonal plane by the erosion of an intermittent stream (Figs. 12, 13). It is 3.0 m. wide by 3.2 m. deep, and its floor is about 50 cm. above the base of the structure at this point. A protective capping or stone facing about 2 m. thick was built over each of the easily eroded faces of the structure's earth core. A final touch to this phase of the construction was the application of

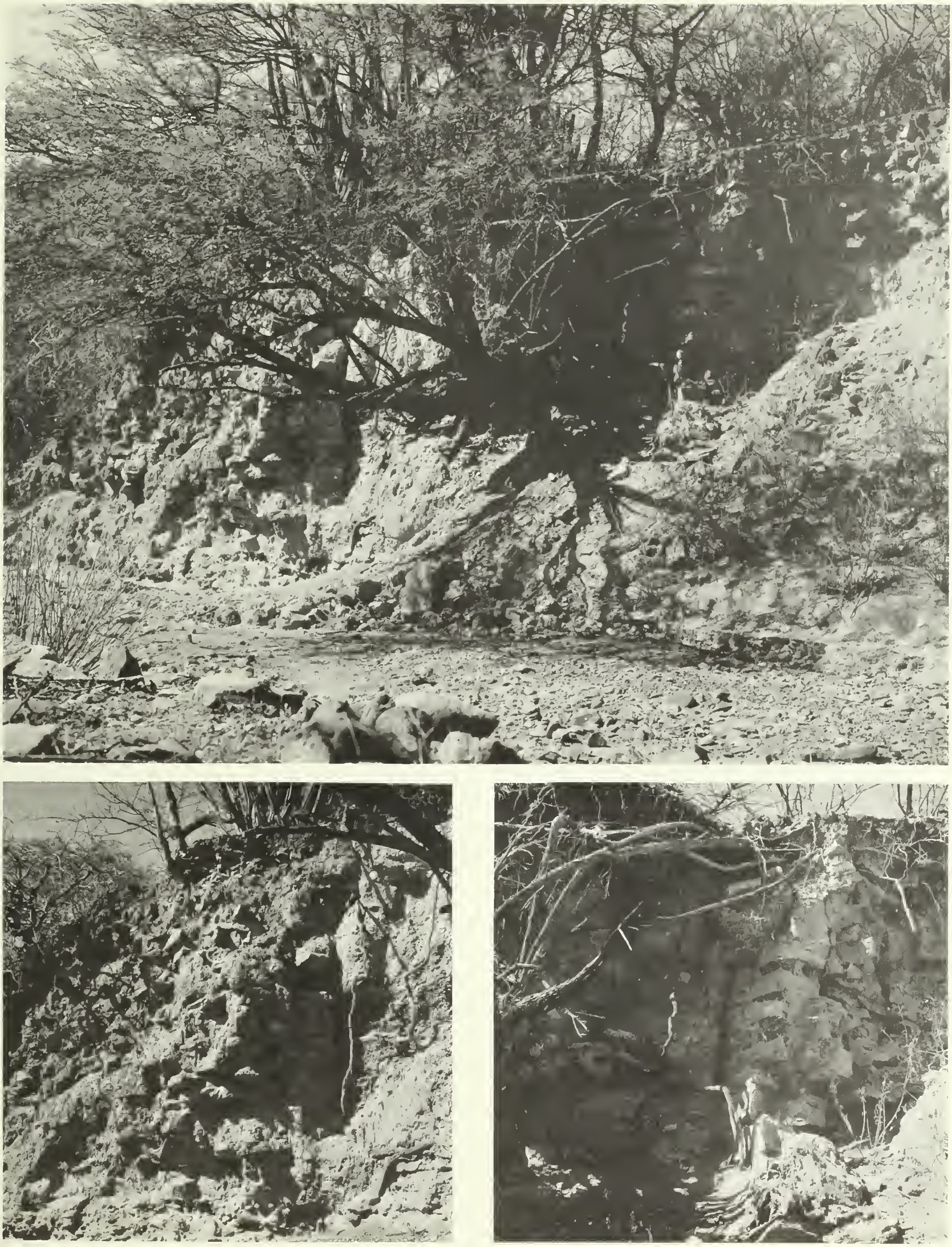


Fig. 13. Spillway in Tr 15, exposed by erosion. Bottom left: detail of southern side of spillway showing masonry construction and silt which filled spillway. Bottom right: detail of northern side of spillway showing water-laid fill in spillway at left.

a reddish clay coating, 2-4 cm. thick, over the stone-faced walls and compacted earth floor. The spillway is filled with the same type of silty alluvium found behind Tr 15 and Level 2 of Tr 435 (see Fig. 13).

With the second building level, a new spillway had to be constructed within the Purron Dam. Due to the silts deposited behind the first dam, the depth of the basin behind the second construction would have been of more or less constant depth the entire length of the dam. However, because of the original uneven nature of the canyon floor at this point, the dam was already necessarily much higher along its southern portion than at the northern extreme, a condition that remained constant throughout the various later rebuilding stages. No evidence was seen that indicated the incorporation of a spillway in the southern end of the dam. Yet it is possible that the well-constructed, thick facing of the western façade was part of a protective capping, like that observed in Tr 15, serving to protect the poorly consolidated core of the structure from the erosive action of the water flowing over the great height of the dam at this point.

We do, however, have somewhat more substantial evidence that spillways were situated along the northern half of this dam. First, an elongated mound of earth and small-to-medium gravels was discovered apparently leading from the westernmost spillway discovered in Tr 15 toward the northern end of Tr 435. Another such feature of approximately the same height and width but longer was found leading from the second of the spillways, located in the approximate center of Tr 15, toward the northern half of Tr 435. An attempt to explain these two features has produced two possibilities. They may be merely mounds of gravel and earth deposited in front of the spillways by the turbulence of the water as it passed through these breaches in Tr 15, or they may be remnants of canals. In either case they indicate water movement toward the northern end of Tr 435, the probable location of its spillways. If these features are canals leading from Tr 15 to Tr 435, we are then confronted with the problem of their functions, considering that they are located within the reservoir area. A possible function would have been to channel water coming down the canyon directly to a spillway in the main dam to be then channeled to the fields. This might have been necessary with unexpected rains during the dry season or at the very beginning of the rainy season. With the onset of the rainy season and for some months thereafter, these canals would have been submerged as the water gradually backed up behind the dam. As the water went down in the reservoir, the canals would have had to have been cleaned of silt or redug completely.

Additional evidence indicating the location of spillways at the northern end of Tr 435 is supplied by a T-shaped deposit of silts and gravels, with the crossbar of the "T" parallel to the front or west side of the dam and the stem leading down the canyon toward the alluvial fields where the present-day cultivated fields are. According to the Tehuacan Project's geologist, Jean Brunet (1967: 85), these water-laid deposits correspond with those behind the main dam belonging to building Levels 2 and 3. The general form and location of this feature, partially exposed today by erosion, lead us to suspect that it functioned as a single large canal that channeled the water from the dam to the fields. Alignments of large stones and boulders were found bordering the edges of this feature where a road crosses the low mound of silts and gravels (see Fig. 9). Although perhaps merely belonging to a fortuitously located structure of some sort, these parallel lines of stone may well represent a portion of the walls of a canal. Whether this feature is a mound of silts and gravels caused by turbulent water action or an actual canal filled with silts and gravels can only be determined through excavation, as can identification of the similar features found within the reservoir.

THIRD LEVEL OF CONSTRUCTION

Level 3 may represent repair on the summit and western face of the main structure rather than a distinct building stage. The relative thinness of this level and the absence of the retaining and reinforcing walls are, perhaps, the best indications of this interpretation. Additional stages of building are not apparent in Tr 15, although it is quite possible that some of its superimposed platform mounds were added during this or subsequent periods of construction on the high dam.

A further consideration reinforcing our impression that Level 3 is only a repair of Level 2 is that no evidence was found indicating any change in the location of the spillways and canals in either the smaller or the larger dam. Thus, Tr 435 probably functioned for years after the repair of damage caused by inundation, before the alluvial deposition increased to a height where danger of another flooding became imminent or the dam failed to function efficiently and the building of Level 4 was initiated. A rough estimate of the area of the reservoir during the second and third periods of construction suggests a minimum of about 500 by 400 m. for Level 2, and a maximum area of about 600 by 400 m. after Level 3 was added. The alluvial silts deposited in the reservoir in front (west) of Tr 15, as well as those deposited behind it from the settling out of reservoir waters and the piling up of heavy erosional flows coming down the canyon, resulted in an alluvial build-up about 3 m. thick around this structure.

FOURTH LEVEL OF CONSTRUCTION

Apparently, Level 4 was built in three or four stages, probably immediately following one another. The first stage consisted of surfacing the top of the previous level of construction with a thin layer of rock. However, this layer may have been instead the surface of Level 3; we were unable to be sure of this. A wall-like structure was then erected along the western edge of the summit, a few centimeters back from the inside edge of the facing materials of Level 2. The well-prepared materials and fine workmanship involved in this structure suggests the possibility that it stood as a separate entity on top of the dam, built at the same time as Level 3 or put up between Levels 3 and 4. The second stage of building in Level 4 involved the placement of fill, some 4 m. thick, again composed of earth and small stones, and compartmentalized by retaining and/or reinforcing walls of thin rock slabs built from 3 to 5 m. apart and paralleling the long axis of the dam. These walls were dry laid and from 75 to 150 cm. thick. The next stage was the construction of a similar layer of retaining walls and fill, also about 4 m. in thickness, which overlaid the first. The distinction between these two levels of fill it quite evident, as the retaining reinforcing walls compartmentalizing the fill are not continuous from one level to the other, are of differing widths, only partially overlapping, and sometimes do not correspond to one another at all. The fourth, and final, stage of this construction level was filling and facing the west slope of the dam to its new elevation. This was accomplished by heaping a quantity of rocks and earth against the west face of the walled-in fill of the second and third stages, just described. This sloping addition extended down to the floor of the arroyo in front of the first level of the dam and was faced neatly with coursed, squared blocks of stone. Erosional debris conceals any facing the east slope might have had. Level 4 brings the dam to its greatest height, about 18 m., not including Level 5's superimposed structures.

With one important change, basically the same systems of draining the reservoir and channeling the water to the cultivated fields are indicated for Level 4 as were suggested for Levels 2 and 3. Again the spillways were probably located near the northern end of the dam, but evidently the large canal taking the water from these spillways was modified, possibly because of the difficulty in removing the thick layers of silt and rock deposited in it by the water passing through the spillway. A new canal was dug parallel to the western face of the dam, and led to the deeper southern side of the canyon, through the deposits of the earlier T-shaped formation, from whence it probably turned west toward the fields to be irrigated. This canal may have served partially or primarily to drain away water seeping under the dam during periods when the reservoir was nearly full. This is a problem today with earth-fill dams, and it would have been aggravated for the Purron Dam by the probable absence of solidly constructed masonry foundations for the rock and earth superstructure. If water seeping under the dam were allowed to accumulate instead of being drained away, the heavy masonry facing might slump.

The course of the new canal cannot be traced after it reached the talus slope of the south canyon wall, since this area has been heavily eroded by the modern stream. We were unable to find any further evidence of a canal running toward the west.

The completion of the fourth rebuilding resulted in the maximum expansion of the reservoir, with a maximum depth of about 8 m. and an area of about 400 by 700 m. The enlargement of the reservoir capacity, in addition to the build-up of sediments within the basin and around Tr 15, undoubtedly resulted in either the complete inundation of that structure or inundation so nearly complete that only the tops of the platform mounds were exposed, like islands, above the water in the reservoir. Although the inundated portions of Tr 15 may have been abandoned only while the water in the reservoir was high enough to cover them, any use during the dry season would have necessitated annual cleaning and rebuilding to remove the silt and repair the damage from erosion.

Apparently at the end of this period of use, the dam — as well as all or most of the sites in the Canyon Lencho Diego — was abandoned. During approximately 1,000 years of abandonment, the two intermittent streams very likely made large inroads into the structure. This abandonment, its effects upon the area and the structures involved in this study, will be discussed further below.

FIFTH LEVEL OF CONSTRUCTION

The fifth, and final, stage of construction may have involved only the addition of structures to the summit of Tr 435 with no further enlargement of the dam itself. Nothing of importance pertaining to this building level can be seen in the stream-cut profile we have drawn upon to interpret the other building levels. Some rather jumbled or disturbed material, about a meter in maximum thickness, may be seen at the top of the dam, overlying the Level 4 fill. We were unable to determine if these materials formed the top layer of building Level 4 or the base of Level 5. Atop this layer, however, are the various low building platforms and the large central pyramidal structure illustrated in Fig. 9. The central structure is 65 m. long by 30 m. wide by 5 m. high. We can venture little concerning the techniques used in building this and the other structures, as no cleanly eroded cross-sections were found, and we lacked time to excavate any. Assuming the platforms and the pyramid to be similar to the majority of such structures in Mesoamerica, they probably consist of a rubble fill with a well-constructed stone facing, which may or may not have had a plaster overcoating.

Interestingly enough, Jean Brunet (1967: fig. 49) noted that since the dam fell into disuse, the two large intermittent streams have modified their courses in the process of cutting through the dam. The Arroyo Lencho Diego appears to have taken the path of least resistance after the dam was breached. Near the north end of the dam a braided channel partly destroyed the canal used with Level 4, although some traces remain. A little further downstream this channel veers away from the canal and toward the south side of the canyon. At the south end of the dam a straight erosion channel was formed, which may follow the line of a former canal, but no traces of such a canal can be observed. In the meantime, erosion channels in the alluvium of the reservoir area began slowly to erode the eastern face of the dam at its southern extreme. As this east to west erosion was taking place, there was probably also a contemporaneous west to east erosional action upon the western face of the dam near its southern end, in the vicinity of the canal we suspect existed near the south wall of the canyon. Little by little the erosion continued headward until the reservoir was "captured" and joined the westward flowing channel. About the same time the Arroyo Lencho Diego itself was "captured" in basically the same manner by another intermittent stream draining the small canyon immediately west of the Cerro Lencho Diego. It is unlikely that the course of either stream has changed greatly since.

Chronology

As we note in the discussion of other types of water control systems discovered during the survey of the Tehuacan Valley, dating such systems is of prime importance but is extremely difficult without extensive excavation and often is not possible even then. In the study of the Purron Dam complex, however, the dating and interpretation have been greatly facilitated not only by erosion, which has exposed the stratified levels of construction and alluvial deposition, but also by the detailed excavation of two caves with stratified deposits located within the same canyon. Were it not for the thorough excavation of the Abejas and Purron caves, and the detailed interpretation of the materials found therein (see other volumes in this series), we would have to be content with the rather scanty chronological information from the visible stratigraphy of Tr 435 and Tr 15 and from potsherds collected from the surface.

The relative dating of the five levels of construction in the Purrom Dam complex is based on their stratigraphic position in relation to each other and to the stratified layers of alluvial deposits on the canyon floor. An "absolute" dating of the construction periods is attempted by comparing sherds from levels in the southern profile of dam Tr 435 and from other structures within the complex with pottery from the well-defined stratified layers of Purron Cave that have been dated by means of the radiocarbon technique (Fig. 3). In addition to pottery, well-preserved remains of cultivated plants, some of which could only have been grown locally with some form of irrigation, were recovered from certain levels of Purron Cave and indicate approximately when the dam was first built and how long it functioned as a water-control device (see Table 12 below).

The only information about the Canyon Lencho Diego prior to the period of the first dam construction comes from Abejas and Purron caves. Radiocarbon dates from the deepest levels of Abejas Cave indicate the immediate area was first inhabited by about 6000 B.C. The period between this earliest occupation and the building of the first small dam spans some 4,500 years and is represented by Zones G through B in the Abejas Cave and Zones U through J in Purron Cave. Abejas Cave was apparently abandoned about 3000 B.C., to be reoccupied for a short while following 150 B.C.

FIRST PERIOD OF CONSTRUCTION

As noted above, the earliest period of construction observed is represented by the modest beginning of Tr 435. Although the base of this early structure and the surface upon which it was built were not visible in the eroded cross-section, it seems rather unlikely that any smaller structure functioning as a dam had previously been erected in the same location. However, this could only be determined by excavation, which we were not able to undertake. Some 20 cm. below the top

TABLE 12
Plant Remains from Zones J-A of Purron Cave

	Before dam		Functioning of dam					After dam		
	J	I	H	G	F	E	D	C	B	A
Cotton (*Gossypium hirsutum*)			1	*	*	*	*	*	*	*
White sapote (*Casimiroa edulis*)			1	4	3	4	3			
Avocado (*Persea americana*)			1	5			6			
Black sapote (*Diospyros digyna*)			1							
Jatropha neopauciflora				2	2	29	8			
Squash (*Cucurbita* spp.)				2		2		2		
Ciruela (*Spondias mombin*)				2	17	512	254	24	7	8
"Guaje" (*Leucaena esculenta*)					3			1		7
"Pochote" pods (*Ceiba parvifolia*)		1			4		3	3	8	24
"Chupandilla" (*Cyrtocarpa procera*)		3	4	26	48	923	249	61	54	124
"Coyol" (*Acrocomia mexicana*)	1			7	37	68	68	18		1
"Cosahuico" (*Sideroxylon* sp.)	1	3	1	194	92	30	33		1	4
Grass quids	6	2		4	28	109	81	10		3
Maize (*Zea mays*)	20	21	25	37	29	186	91	176	105	212
Agave	2	7	867	188	271	1,911	589	1,075	1,375	245

*Presence of cotton indicated by cotton artifacts.

of Level 1 a lens of light gray ash about 10 cm. thick spanned the entire width of the structure. A number of potsherds were extracted from this layer. These sherds were identified by R.S. MacNeish and represent the pottery types Canoas White, Canoas Heavy Plain, Canoas Orange-brown, Coatepec White, Rio Salado Coarse, and Rio Salado Gray, with the latter two types most numerous. The occurrence of these types together indicates a date in the early Santa Maria subphase for the collection. This distribution of the various types within the layer is, in fact, very similar to the distribution of sherds in Zone I of Purron Cave, a level which can be dated by its close relationships to Zones D and C^2 of the Coatepec site (Ts 368e) as about 750-600 B.C. (see Fig. 3).

We also have information bearing on the date of construction from botanical evidence. In studying the various plant remains from Purron Cave, C. Earle Smith, Jr. identified the remains of cultivated plants in Zone H and later levels, which, in his opinion, could not have been grown in the immediate area without some means of irrigation (Smith 1967). These plants — avocado, black and white sapotes, and cotton — were not present in Zone I or earlier deposits. Zone H has an averaged radiocarbon date of 445±101 B.C. and the deposit probably began about 600 B.C. (see Fig. 3). The dam must have been built and functioning before that time. Thus Level 1 seems to have been constructed during the period of Zone I, or about 750-600 B.C.

SECOND PERIOD OF CONSTRUCTION

Dating the second building level is more difficult as neither ash lens nor sherds were found in the huge profile 4.5 m. high and 100 m. wide. Unfortunately the structure's height made it impossible to clean the sheer face to permit better study. The best chronological clue to the second period of construction came from a test pit measuring one meter square, dug at the edge of the westernmost spillway of Tr 15 and from profiles exposed by erosion in the lowest levels of sediments built up behind Tr 15 and judged to be contemporary with similar sediments behind Level 2 of Tr 435. The pottery types found in association in the test and profiles — Canoas White, Canoas Orange-brown, Canoas Heavy Plain, Rio Salado Gray, Rio Salado Coarse, Quachilco Gray, Quachilco Mica, and El Riego Gray, with the two Rio Salado types most numerous — suggest a middle Santa Maria phase date of about 600 B.C. Both Tr 15 and Level 2 of Tr 435 must have been built about this time.

When the profile of the westernmost spillway of Tr 15 was cleaned, fragments of carbonized wood were taken from the lower 18 cm. of rubble in the northeastern corner. This charcoal was evidently deposited just after Tr 15 was constructed and before the deposition of alluvium behind it and its spillway had commenced. The sample (SI-124) was dated by the Smithsonian Institution's Radiation Biology Laboratory, and we are indebted to Dr. Austin Long of that laboratory for his assistance in evaluating the results. The date of the specimen was 800±60 B.C. Since it is highly probable that Tr 15 was built after Level 1 of Tr 435 and simultaneously with or just before Level 2, the radiocarbon date is in disagreement with the ceramic chronology, which rests on the seriation of thousands of sherds and a closely knit series of radiocarbon dates from many levels of many sites (see chap. 1). One explanation for the discrepancy is that the charcoal is correctly dated, but instead of being contemporary with the construction or the accumulating silt in the spillway of Tr 15, it was washed in from an unknown source upstream. Instead of coinciding with the construction of Tr 15 and of Level 2 of Tr 435, it precedes them by some 150 to 250 years.

THIRD PERIOD OF CONSTRUCTION

Within the gravels and silts of the T-shaped formation just west of Tr 435 and in mounds of similar material found between the north end of Tr 435 and the westernmost spillway of Tr 15 were sherds of Coatepec White, Quachilco Mica, Quachilco Red, and El Riego Gray, with the latter type predominating. This distribution of types, compared with ceramic samples in Zones E and F of Purron Cave and Zone VI of Coxcatlan Cave, implies a date falling in the very late Santa Maria phase or in the very early Palo Blanco phase — about 150 B.C. – A.D. 150. We had identified these deposits as belonging to the time when Levels 2 and 3 of the dam were in use, and this identification fits comfortably with the dating.

FOURTH PERIOD OF CONSTRUCTION

Ceramics and plant remains are the primary sources for dating the fourth building level. The few sherds of Quachilco Gray, Quachilco Mica, Quachilco Red, and El Riego Gray that were dislodged from the profile by several well-thrown stones suggest an early Palo Blanco date for this construction period. Such a date is borne out by the data provided by the plant remains from Purron Cave (see Table 12). The presence of certain plants needing irrigation in Zone D and their absence or abrupt decrease in Zone C indicate that the dam had ceased to function by the time of Zone C. Among the plants that need supplementary water to survive in the Lencho Diego area are avocado and white sapote, both present in Zone D and absent in Zone C. Furthermore, in Zone C there is a definite decrease in amounts of the fruits known locally as chupandilla, cosahuico, ciruelo, and coyol, all of which grow better when well watered.

Finally, the ceramics of Zone C of Purron Cave are like those of Zone B of San Marcos Cave and Zone V of Coxcatlan Cave, dated respectively A.D. 300±130 and 187±96. On the basis of the ceramic evidence, Zone C of Purron Cave must have been laid down between those extremes, or about A.D. 200-300. The botanical evidence shows that the dam had ceased to function by that time, and the fourth period of construction had to be concluded before the above dates.

Zones A, B, and C indicate that small groups occupied Purron Cave for brief periods during the earliest part of the late Palo Blanco subphase, growing crops that did not need a constant supply of water. The dam was abandoned, and the whole Lencho Diego area was relatively unoccupied at this time. Although 76 sites of the late Palo Blanco subphase were discovered in the archaeological survey, none were located in the Canyon Lencho Diego.

FIFTH PERIOD OF CONSTRUCTION

The dating of Level 5 of Tr 435, is based on less certain data than that available for the previous building stages. No sherds were found in situ in either the thin profile of the level which was exposed by erosion or the great pyramid and smaller platform mounds. However, the entire surface of this level of construction and of the associated structures is profusely littered with Venta Salada phase sherds (about 90 percent) and other artifactual materials of that phase. The sherds were compared with the Venta Salada ceramic material from excavated sites located near the dam, Coxcatlan Cave (Tc 50), Coxcatlan Ruin (Tr 62), and a site just northeast of the village of Pueblo Nuevo (Tr 65). It was found that the earliest Venta Salada ceramics represented at the dam are Coxcatlan Brushed Brown and Coxcatlan Brushed Black and the latest, Coxcatlan Polychrome and Texcoco Black-on-red. These four types indicate an occupation in Venta Salada times (about A.D. 1100-1500). Thus, this fifth, and final, construction was apparently accomplished by peoples re-inhabiting the canyon sometime after A.D. 1100 and using the dam not as a water-control device but as a huge building platform upon which they constructed a large pyramid and other smaller structures.

Interpretations

Human habitation of the Canyon Lencho Diego can be traced back to about 6000 B.C. when Abejas Cave (Tc 307) was first occupied. Shortly thereafter, a rock shelter a short distance away, Purron Cave (Tc 272), was occupied. These sites in the rather barren and inhospitable canyon were used only seasonally, primarily during the rainy season when conditions for hunting and gathering were best. The habitation of Abejas Cave apparently ceased after the occupation of Zone B during the middle of the Abejas phase, about 3000 B.C. The seasonal occupation of Purron Cave continued, however.

The first evidence of agriculture in the canyon — two cobs of early tripsacoid maize — were deposited in Zone K of Purron Cave during the Purron phase. Zone K is dated 1925±131 B.C. From this time into the early Santa Maria phase, which commenced about 850 B.C., the cave continued to be occupied seasonally, but now the inhabitants evidently exploited the alluvial deposits of the canyon floor for agricultural pursuits to supplement foods derived from hunting and gathering. The former practice resulted in generally longer periods of habitation and perhaps in biseasonal occupations during a single year. It is likely that other sites in the canyon were occupied during this long period of subsistence farming, though none were found by the archaeological survey.

EARLY SANTA MARIA SUBPHASE

Early in the Santa Maria phase — probably during the time of Zone I in Purron Cave — the inhabitants of the Canyon Lencho Diego erected a small dam, which, evidently, proved successful enough so that it was rebuilt and enlarged to keep it functioning and improve its efficiency. The settlement pattern for this period appears to be on the same scale as the dam, small and limited. The more-or-less experimental dam (Level 1 of Tr 435) extended partially across the canyon narrows. Tr 449, consisting of two small house foundations, is located some 250 m. north of the northern end of the dam. The only other habitation site attributable to this period is Purron Cave, which had two occupations attributable to the early Santa Maria subphase, Zones I and H. It is very possible that other small sites were present and have since been destroyed by the elements or are covered by alluvial deposits. It is evident that Purron Cave served as a habitation, but what of Tr 449? It too could have been a habitation site, but considering the importance of water in a semi-arid region, it might have been a post for guards or attendants of the dam or a religious structure to aid in securing the favor of the gods and the success of the irrigated crops.

The alluvial soil is rich enough in minerals derived from the sedimentary rocks in the area so that application of even small amounts of water at crucial periods in plant growth would have resulted in good crops (see Smith 1967: 220-224). The first small dam probably retained enough water for irrigation so that careful use would insure at least one large maize crop annually, probably even in an especially dry year, and often two crops. Since the estimated volume of the reservoir of the second construction period is over eight times greater than that estimated for the first reservoir, presumably enough water was retained by Level 2 and subsequent rebuildings to produce two (and perhaps three) maize crops a year. By the end of the early Santa Maria subphase, inhabitants of the area were growing with the aid of the dam avocado, black and white sapotes, and cotton (see Table 12).

LATE SANTA MARIA SUBPHASE

During this period many more sites existed in the canyon: Tc 272 (Zone G), Tr 435 (Levels 2 and 3), Tr 67 (northern portion), Tr 15, Tr 450, and Tr 452. Does this increase in the number of sites represent a growth in population, or an influx of population from nearby areas owing to the success of irrigated agriculture in the canyon, or a change in the settlement pattern to more stable villages using stone for building rather than perishable materials? Or does it result from location of sites in areas less likely to be inundated and silted over, or from the growth of more complex ceremonial centers having to do with water and agriculture? The chances are that the dam and resulting irrigation are in some way closely connected with the increase in the number of sites and the apparent surge in population. Whether the dam brought the changes, or the changes in settlement gave rise to the dam, we may at least safely say that the use of irrigation agriculture permitted further population growth and the development of specialization.

The general picture we form of the canyon during this period is one of a series of sites located around a huge dam and its reservoir, the northern limit if the reservoir being formed by Tr 15, a causeway-like structure or dam. The function of the majority of these sites is debatable. We are sure that Purron Cave was still being used as a temporary habitation site. It is possible that the northern portion of Tr 67 served as a guard or tending station, for it appears to have been located at the edge of the canal taking water from the spillways of the dam to the cultivated fields. This may also have been the function of the mound-shaped site Tr 450, located just north of Tr 435. Without excavation we may only guess that the other sites situated near Tr 435 and Tr 15 were primarily habitation areas.

The purpose of the main dam is rather apparent and has already been discussed, but what of Tr 15? As implied previously, it may have functioned as a subsidiary dam to collect all possible small amounts of water reaching the structure and channel them via canals directly to the spillways in the main dam, and from there to the fields. This process would ensure that a good percentage of water from late dry-season and early wet-season rains would reach the fields without becoming trapped in the reservoir to be lost by evaporation and seepage. It is possible, too, that Tr 15 was originally built to serve as a cofferdam to divert water through its spillways to the canals and channel it through an already prepared section of Tr 435, allowing the remaining work to be completed on the main dam without fear of a washout. It may also have served as a "breakwater" to receive the initial brunt of flash floods, thereby protecting the precious larger dam. In addition to protecting the main dam from damage, it may have served as a filtering device to stop much of the alluvial silts and gravels from entering the basin of the reservoir, thereby prolonging the basin's usefulness and delaying the necessity of rebuilding the dam.

Another possibility is that this smaller dam upstream was designed to permit planting of the reservoir area itself, if it received a good flooding very early in the rainy season or was drying out late in the season. The smaller dam would have diverted subsequent flow of the stream directly to the irrigation canals for use downstream and perhaps would have allowed a crop to mature in the reservoir area. If this was an early season crop, the reservoir could have been filled after it was harvested, and following the first watering of downstream fields. If it was a late season crop, the upstream dam would merely have been protection against any unseasonable late rains. Thus the reservoir area could have served as a field of the "bolsa" type, using the technique still employed today in northern Mexico of planting low-lying land after a single heavy flooding, without subsequent irrigation. But perhaps these interpretations are too practical. There is, of course, the possibility that Tr 15 was a causeway, somehow connected with the religion of the inhabitants, and was built as a base for temples and the like — stranger edifices than this have been built in the name of religion.

EARLY PALO BLANCO SUBPHASE

This period marks the last rebuilding of the main dam and the abandonment of nearly all of the sites located within the canyon. The only sites evidently in use within the canyon proper at this time, in addition to the dam, are Abejas Cave (a short occupation represented by Zone A), Purron Cave (Zones F-D), and Tr 15.

For some unknown reason Tr 15 was no longer considered a necessity to the local inhabitants and was not rebuilt when Level 4 was added to the main dam. Study of the soils along the smaller structure indicates that all but the southwestern end was inundated and that the platform mounds and structures on top probably remained as islands in the reservoir behind Tr 435. The sherds collected from these platform mounds indicate that they were in use during early Palo Blanco times, perhaps only after the water in the reservoir had receded enough to allow easy access to the structures.

Contemporaneous with the abandonment of the sites within the canyon itself in the early Palo Blanco subphase, or perhaps somewhat earlier, was the establishment of many hilltop sites nearby, generally to the south and east but in at least one case to the north and west. Five of the fifteen new sites formed at this time are in the immediate vicinity of the canyon. Tr 75 is located just south of Tr 435, on top of the mesa forming the southern wall of the Canyon Lencho Diego as it narrows. Tr 73, Tr 78, and Tr 79 are on hills at the mouth of the canyon. The latter three sites are well situated for easy access to the alluvial flat watered by the dam, as is Tr 132, located on a hill northwest of Tr 435. The remaining cites established during this period — Tr 74, 76, 77, 84, 101, 102, 103, 104, 106, and 109 — are located primarily on hills and high elevations along the edge of the canyon drained by the Rio Tilapa about 2.5 km. to the east. We have no way of explaining the change in settlement location initiated at this time, except to note the very obvious strategic advantage of hills over bottomland areas, and the fact that such locations do not occupy lands which would normally be cultivated. Probably the better water supply offered by the Rio Tilapa, which seldom runs dry today, was a prime factor in the founding of the many sites in that area.

The end of this period is marked by the abandonment of the large dam as well as the majority of the sites established at the beginning of the period.

LATE PALO BLANCO SUBPHASE

This period saw an apparent partial abandonment, or decrease in population, of the Lencho Diego and Rio Tilapa canyons. Pottery collected from Zones A-C in Purron Cave and from Tr 73, 79, and 132 indicates that possibly only these three of the nineteen sites of the previous period were occupied at this time, and even they were on the wane. Sherds from four new sites, Tr 92, 99, 100, and 105 in the nearby Tilapa Canyon, indicate that they were first inhabited during this period, sometime about A.D. 300-600.

In the light of the apparent success of the dam and the earlier growth in population, we have no evidence to explain this rather sudden and extensive abandonment. There is, of course, the possibility that the abandonment of sites does not represent an abandonment of the area but only a movement of peoples from several sites to join those of an already existing nearby community. The complex social implications involved in the abandonment or moving of a settled community are such that probably only a drastic or very important event influencing the lives of the inhabitants caused such an action. Much more work is necessary here before we can state what influenced the majority of the inhabitants to change their residence.

EARLY AND LATE VENTA SALADA SUBPHASES

This final period of prehistoric occupation is characterized by the slow reoccupation of some of the sites founded during the previous period. The ceramics collected from the surface of Tr 75 and Tr 78 show that they seem to have been reoccupied early in the Venta Salada phase. Tr 82, 83, 85, 95, 97, and 98 were probably inhabited in early Venta Salada times, whereas Tr 80 and 94 were occupied until late in the phase.

There evidently was also a reinhabitation of the Canyon Lencho Diego persisting from early through late Venta Salada times. The southern portion of Tr 67 was constructed on and partially of the very gravels deposited by the canal serving Levels 2 and 3 of the dam. In addition to the structures built on the dam's top, terrace walls were built near the summits of natural talus slopes, which were then somewhat modified in form and faced with stone to produce large terrace-like monuments (Tr 453) or platform mounds (Tr 451).

It is also quite possible that some building dating to this period was accomplished on the already present platform mounds on the northern half of Tr 15, since pottery of this period is more heavily concentrated on the surfaces of these mounds than on the surrounding alluvium. Venta Salada sherds were also found in large quantities on the surface of the structures located on Tr 15 just below Tr 451. It was not possible, however, to tell if these structures were built, or rebuilt, at this time or if the pottery merely came from Tr 451.

A prominent feature, similar in form to the built-up and faced talus slopes at Tr 453, was located just west of the southernmost portion of the Purron Dam (Fig. 9). This feature appears to have been made, or at least modified, by human endeavor. However, as it lacks pottery and the usual architectural features of terracing and facing, it is possible that it is a structure that was not completed. Because we have so little information we are designating the feature an "uninterpreted structure" and have included it within the site survey as probably being associated with the Level 5 construction on the dam.

The return to the early Palo Blanco pattern of locating sites on elevated areas during this period may explain the use for further construction of the high eminence provided by the abandoned dam. It is possible that this settlement pattern resulted from a rapidly expanded population, needing the rich alluvial bottomlands free for food production by seasonal dry farming. Fitting with this idea is the absence at this time of identifiable sites on the floor of the canyon. However, the use in the canyon of small houses of perishable materials which would leave little or no trace a few years after abandonment, is entirely possible. These temporary and easily built structures would have taken up very little farm land. Such simple huts are used in many of the fields under cultivation today throughout the Tehuacan Valley (Figs. 45, 46). There were substantial quantities of Venta Salada pottery on the canyon floor, which also suggests that the dam never again functioned as such, after it was abandoned. Because of the rapid alluviation it is not very likely that the quantity and type of sherds found on the floor of the canyon would be on the surface today if the dam and its reservoir had been in use in Venta Salada times. Failure to re-use the dam in this phase suggests that the erosional damage was so great that repair or rebuilding was considered impossible.

Ceramic types (Teotitlan Incised, Coxcatlan Polychrome, Coxcatlan Striated, and Texcoco Black-on-red) found on the Venta Salada sites within the canyon and near the Rio Tilapa to the east indicate the area was quite densely inhabited at the time of the Conquest. The intensive irrigation farming necessary to supply the needs of a large population in this area suggests that some sort of replacement for or successor to the Purron Dam was built during this phase, although the primary site survey failed to disclose any other dam or irrigation system in the area. It would be worthwhile, however, to examine more intensively the upper reaches of the Rio Tilapa, since the concentration of late Palo Blanco and Venta Salada sites in the area may have been made possible by a source of irrigation water.

Manpower Estimates

In sheer mass and volume, the Purron Dam is truly a monumental work. A rough estimate of its total volume at the completion of the fourth level of construction is about 370,000 cubic meters of earth and stone. Of course, this is an accumulation of four levels of construction; however, if we take only the fourth-level construction into consideration, the volume is still enormous, some 192,000 cubic meters. Figures on the amount of earth that can be excavated under primitive conditions are difficult to obtain, but interviews conducted early in this century with elderly Pima Indians in Arizona (Southworth 1931) relate to a time when hand labor was done with a minimum of metal tools or other modern equipment and indicate that in the sand and gravel of the Salt River Valley, a canal builder could move approximately 1.6 cubic meters a day.

Using this estimate, we calculate that at least 120,000 man-days of work went into the dam's fourth level of construction. In estimating the number of men involved we must recognize that the period of major construction was limited to the eight months of the dry season, as the water coming down the canyon during the remaining four months of the year would have interfered with building or destroyed a partially completed level of construction. With 600 men working on the project, building Level 4 would have taken about 200 days. This, however, is probably a low estimate as much more was entailed in the building of the dam than just the movement of earth, upon which we have based our estimate of the man-day work capacity. As there is no evidence of a structure which might have served as a cofferdam in this period (as Tr 15 perhaps did for building Levels 2 and 3), it is doubtful that a smaller work force labored longer in completing the major portion of the construction in Level 4. Even an estimate nearer a thousand men to complete this work during a dry season does not seen unrealistic. The large number of villages in the area at the time of the construction indicates sufficient population to have supplied a thousand capable men. Unless the division of labor was stricter than it is today, women may also have aided in the building. Although primarily bound to their household tasks, today women do help with agricultural tasks in times of emergency or if the needed manpower is not available.

After the first draft of the above paragraphs were written, Charles J. Erasmus published his significant experiments and calculations in the building of Mesoamerican monuments (Erasmus 1965) which provide an appropriate basis for estimating the possible manpower implications of the Purron Dam complex. We have let our previous efforts remain, however, since comparing them with the estimate discussed below may be of interest.

Erasmus first provides records of "how much earth a man could move in a day," based on observations and measurements from an experiment with workmen in a Mayo village of Sonora. His conclusion is that for a five-hour day (appropriate for hard labor in a warm climate, and certainly a realistic basis for comparisons with the past), with one man digging and one man carrying, the day's total for the man carrying would be 3.17 cubic meters when the earth was carried 50 m. and 1.76 cubic meters when the earth was carried 100 m. The former figure is reassuringly close to Southworth's 1.6 cubic meters, when the ill-defined conditions that his figure represents are considered. However, Erasmus provides figures that are more appropriate for the construction of a complex structure with internal masonry reinforcement and masonry facing, such as the Purron Dam. He concludes for the architecturally more sophisticated structures of Uxmal in Yucatan, where a very high proportion of the total mass is rock, that 5.25 man-days per cubic meters of fill would be required. To take into account, at least slightly, the relatively simple nature of construction in the Purron Dam, we will arbitrarily reduce the figure to 5 man-days per cubic meter. For the construction of the fourth level, which we believe must have been accomplished in a single eight-month period between rainy seasons 960,000 man-days would have been required. If we assume that in this period of approximately 240 days there would have been 220 days available for work, the 960,000 man-days could have been performed by a labor force of 4,364. If longer work days were achieved or if less labor was involved in quarrying and carrying, or if more earth and less rock were used than in Erasmus's experimental model, then the Purron Dam would have needed a smaller work force. We suspect that an estimate of 4,300 men may be a maximal figure and a good case could be made, with appropriate new experimental data, for a smaller work force. Nevertheless, the indicated total is far above our simple estimate based on merely the amount of earth that could be moved in building canals in the Arizona desert.

The magnitude of this construction thus suggests a sufficiently complex social organization to secure and control such a large body of laborers. The earlier levels of construction were smaller and probably accomplished by fewer workers, possibly over a longer period. It is conceivable that the first dam was built by cooperation within a single small village; ideally, ten men could have completed the construction in not much more than 100 days. However, with the volume of work greatly increased in subsequent levels of construction the labor force must have been increased accordingly. By the time Level 4 was built, ties of cooperation would have included all the nineteen nearby settlements, and if the highest estimate of manpower is correct, settlements in the whole valley must have been included. Perhaps the form of social organization functioning in the Tehuacan area was a smaller-scaled version of that reconstructed for the people of Teotihuacan and Monte Alban (Armillas 1948: 107), who produced highly developed monumental architecture during the same time period we are discussing.

Reservoir Capacity

In conclusion, we should consider the efficiency of the dam complex. Was it really able to irrigate enough land to justify its existence? As has been noted, with every rebuilding of the dam, it apparently was enlarged to provide a greater water supply for the irrigation of more land which, in turn, would provide more crops for a constantly increasing population. Although only rough estimates can be offered, the reservoir's increase in area and volume can be calculated as follows, taking into account the silting that probably nearly filled the potential capacity behind each dam level by the time the next was built: 1st Period: 170 by 140 m., capacity 37,000 cubic meters; 2nd Period: 500 by 400 m., capacity 1,430,000 cubic meters; 3rd Period: 600 by 400 m., capacity 970,000 cubic meters; 4th Period: 700 by 400 m., capacity 2,640,000 cubic meters.

Let us now examine whether the estimated reservoir volume of Level 4 could have efficiently irrigated the entire alluvial flat, measuring 1.5 by 4.5 km., to the southwest. The Estudios y Proyectos A. C., which made the general survey of the Rio Salado subarea for the Papaloapan Commission estimated that 9,000,000 cubic meters of water are needed to irrigate 900 hectares of land (or 10,000 cubic meters per hectare) in the immediate area of Tilapa (Comisión del Papaloapan 1954: 45). Since these estimates are for modern farming needs, including the much higher water requirements of sugar cane instead of maize, it seems probable that the water needed in prehistoric times to irrigate the 675 hectares of land available would have been much less than the 6,750,000 cubic meters needed by modern standards. Although evaporation and seepage from the reservoir probably reduced the amount of available water below the estimated capacity of the reservoir, this may have been offset by a flow in the Arroyo Lencho Diego sufficient to fill the reservoir more than once a year. It should be noted that there is no basis for suspecting significantly greater rainfall, or flow in the arroyo, in the past; a climate essentially like the present is indicated for much longer into the past than the three millennia we are concerned with here (see vol. 1 of this series). An important factor in judging the area that the Purron Dam complex might have irrigated, and, unfortunately, a quite unknown factor, is the way in which water was applied to fields in prehistoric times, and particularly the quantity customarily used. It is quite possible, in view of the efficiency of village farmers using simple hand methods today in many parts of the world, that water was used in smaller amounts than is today considered appropriate by government experts planning large-scale hydraulic innovations. Finally, it is probable that at least a small part of the land lying below the Purron Dam could have been irrigated directly from the Rio Salado, as it is today, with only the higher elevations of the presumed 675 hectares wholly dependent on the Purron Dam. Therefore, even without a firm basis for estimates of the area it actually served, we can conclude that at its maximum the dam could have made a significant contribution to the irrigated farming of this part of the Tehuacan Valley.

The failure of the dam to make available enough water to meet the demands of the growing population may have resulted in its abandonment when its reservoir had silted up to a point where maintenance was not worth the effort. This failure may well have caused the general abandonment of the canyon in favor of a larger, more dependable water supply, such as that offered by the Rio Tilapa only 2.5 km. to the east. Because of the lack of water, perhaps the Canyon Lencho Diego was only inhabited during the rainy season after the dam went out of use. If this is the case, the inhabitants would have returned to the same basic pattern of seasonal occupation indicated in Purron Cave before the building of the dam.

The questions raised by this brief historical reconstruction can be answered only by means of more work in the immediate area and the Tehuacan region in general. Intensive survey of the many canyons to the east and west of the Canyon Lencho Diego might disclose water control features preceding and following the Purron complex. Excavation of the dam complex and nearby sites would undoubtedly provide better evidence of the techniques of dam building and irrigation and better dates for the levels of construction and periods of use, as well as further insights into the interrelationship of irrigation with the prehistoric economy and the society as a whole.

Other Dams

In addition to the many terrace walls constructed across small drainages (which, although sometimes misleadingly termed "check dams," did not function as true dams) our survey disclosed two additional struc-

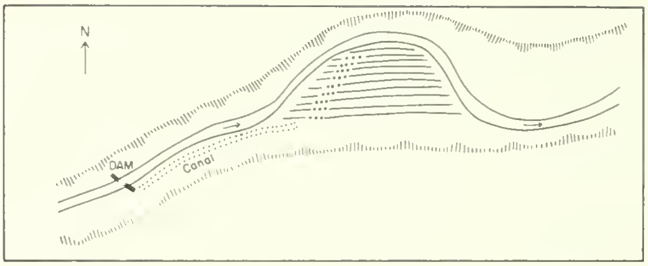


Fig. 14. Sketch map (not to scale) of Tr 447, with masonry-faced earth dam, stone-bordered canal, and field with stone borders of slabs. Boulders near the west end were probably removable, for control of water distribution to terraces.

tures apparently designed to block the passage of water in its natural course and impound it in a small lake or reservoir. These structures are about the same size, but are dwarfed by the Purron Dam which in its final stage of construction was nearly 600 times the volume of either of these smaller dams. Although we have relatively few details concerning them, they deserve mention as a reminder that dam building was undoubtedly more extensive prehistorically than our evidence can demonstrate. It is highly improbable that either the one large or the two small dams reported here is unique; instead, they are all that have both survived and been recognized. Further search would, we are convinced, disclose much more evidence.

The first of these smaller dams (Fig. 14) was discovered in the west-central portion of the Tehuacan Valley. Located approximately 6.5 km. south of the city of Tehuacan and 2.5 km. west of the town of San Marcos, Tr 447 lies within Tecorral Canyon about 1.5 km. upstream from its mouth.

Approximately 6 m. wide by 30 m. long and 3.5 m. high, the dam was constructed with an earth and rubble core which was faced with dry-laid unmodified cobbles and boulders. Despite the fact that the structure has been breached by the intermittent stream which drains the canyon, the ends of the dam remain at either side of the stream bed and indicate the feature was built as a solid unit to block the drainage completely.

Apparently leading downstream from the southern end of this dam are two parralel lines about 75 cm. apart of unmodified stone slabs and boulders that may well represent a canal. Running northeast of the dam for some 60 m., the lines of stone drop abruptly as they reach the edge of a field evidently once used for agriculture. Situated on a terrace formed by a large bend in the stream, this field of 50 by 50 m. is characterized by about ten linear field borders of stone slabs. These borders are one course high with the stones being set on edge in the soil in such a manner that they follow the contours of the terrain while generally paralleling the flow of the canyon's drainage. Near the point where the supposed canal enters the field the generally homogeneous nature of the linear rock borders is broken by the presence of several boulders. These boulders, forming a discontinuity 30 to 50 cm. long in the borders, probably served as a form of sluice gate, the manipulation of which would control the efficient allocation of water to each of the bordered portions of the field.

In the light of the features discovered, the apparent function of this dam was to block the drainage completely and form a reservoir some 30 by 60 m. in area, up to 3.5 m. deep, with a capacity of about 3,000 cubic meters. The water could then have been metered from the reservoir to the fields by means of the stone-lined canal. Upon reaching the field, the required number and sequence of plots could be irrigated by the order in which the boulder sluice gates were removed to allow the passage of water through the linear field borders. There is, however, one inconsistency in the otherwise rather clear manner in which the system evidently functioned. The problem consists of the manner in which the water passed from the reservoir into the canal leading to the field. As this presumed canal is built on a level just slightly below that of the top of the dam, it would be impossible for more than a very small amount of water to flow from the reservoir into the canal by gravity. The problem is further complicated by the fact that the canal apparently has its points of origin about one meter away from the southern end of the dam, in which, incidentally, no evidence of a spillway was found.

Considering the data at hand, we suggest three alternative methods in which this system may have functioned. First, perhaps no attempt whatsoever was made to channel the water directly from the reservoir, through the dam, and to the fields. Instead, this process may have been accomplished manually by dipping the water from the reservoir to the canal by means of ceramic vessels or skin bags. Second, perhaps the canal in question does not really belong to the dam discovered but to another which had been built further upstream and has since been destroyed by erosion. In such a case, the canal could have transported water from a dam having an efficient spillway system. Correspondingly, dam Tr 447 could have functioned in the same general manner and served to provide water to a field farther downstream than that just described. However, because no evidence of another dam was found upstream and no canal was discovered leading from the dam present to another field downstream, this possibility seems extremely unlikely. Third, a "canoa" or split and hollowed log, such as those still in use in the Tehuacan Valley and elsewhere today, might have taken the water out of the reservoir through an aperture in the dam too small to have left a discernible and identifiable trace, since the canoa would eventually rot and little or no masonry to support or supplement it would have been required. The use of a canoa would explain the puzzling gap of a meter between the dam and the beginning of this canal.

Just how much labor was involved in the construction of this dam and what induced its building? Although speculative in nature, we can suggest answers to these questions. For example, the estimated volume of the dam itself is about 630 cubic meters and, if we again use Erasmus's figures (1965), slightly modified to an estimated five man-days per cubic meter, construction of this dam would have required 3,150 man-days. Since this dam is both simpler in construction (very little masonry) and small in size, reducing the distance from which materials would have to be brought, we suspect that two-thirds or one-half this estimate would be more appropriate — 2,000 or 1,500 man-days. If the work occupied a more or less continuous period of 200 days, it could have been accomplished by ten men; the same work would require fewer adult males if a sense of urgency and the pressure of intense community cooperation brought women and children to the work. Thus, the number of people that can be estimated as required for this construction corresponds reasonably well with the small seasonal occupations for Tecorral Canyon and its vicinity indicated by the stratified deposits of San Marcos and Tecorral caves, about 600 m. upstream from the dam. Just as with the construction phases of Purron Dam, it is probable that construction would have to be essentially completed during a single dry season, since the partially built dam would risk great damage by the floods that canyons like Tecorral occasionally experience from June through September.

Turning to the reason why this particular dam was constructed, two explanations come to mind. First, although the canyon may have received sufficient moisture from rainfall for the production of crops by dry farming or seasonal farming, the problem remains as to how this water was distributed to the fields. Even with the construction of linear field borders and low terraces, the fields in Tecorral Canyon may not have received enough water to produce a large crop because of the rapid run-off of rainwater from the steep slopes of the canyon. In other words, the water could not penetrate the soil effectively before being drained off by the relatively large intermittent stream channel cut into the canyon floor. Perhaps it occurred to the local farmers that by blocking this drainage they could retain enough water to irrigate their crops easily when the need arose and to insure a good crop even if the annual rains were unusually light.

Another idea, which may have developed independently or from that just described, is construction of the dam to make available enough water to produce a second irrigated crop from the same field. Even though the components of the caves excavated indicate only spring and fall occupations, there is the possibility that the farmers using the dam and field of Tr 447 did not utilize the caves continuously but lived in nearby open sites in dwellings of perishable materials which have long since disappeared. With this possible function in mind, the question arises as to how such a second crop would compare with the seasonal harvest — was the dam really efficient enough to merit the effort invested in its construction and maintenance? Using the estimates of the Comisión del Papaloapan (1954: 34, 45) which indicate that approximately 10,000 cubic meters of water are necessary to irrigate one hectare of land in the Tehuacan Valley today, including fields of sugar cane, and assuming that much less was needed for the crops and techniques of the past, we find that this dam was quite efficient. The estimated volume of its reservoir is 3,500 cubic meters and the only land it appears to have irrigated is a field about 50 by 50 m., or about one-quarter hectare. Thus ample water may have been collected for irrigating two crops a year. However, because of the arid nature of the canyon, the sufficiency of water may be more apparent than real owing to loss by evaporation and use of water in the reservoir for household purposes by those tending the fields and the dam, whether they were in residence or only occasionally visiting the fields.

No habitation site was found in the immediate area of Tr 447. This may be because all traces of temporary structures made of perishable materials have disappeared or the fact that these early farmers may have lived in some of the caves that were apparently occupied at the time the dam and field were in use. The few fragments of ceramics found in association with the dam and the field indicate a late Palo Blanco phase date (ca. A.D. 300-700) for the use of these features.

TR 446

Another small dam was discovered to the west of the Tehuacan Valley in the southwestern portion of

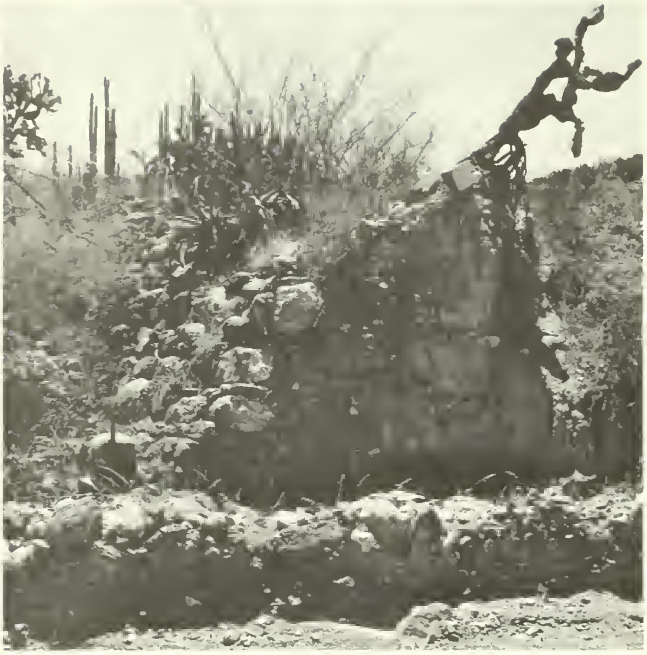


Fig. 15. Remnant of dam Tr 446, about 3.5 m. high.

the Zapotitlan Valley, about 10 km. south-southeast of Santa Ana Teloxtoc and 2.5 km. northwest of the village known as Colonia San Martin. In many ways this dam is like the one found in Tecorral Canyon. The general construction is the same (Fig. 15) and, although erosion has completely destroyed the center portion and one end, the estimated length of about 35 m., the known height of about 3.5 m., and the known width of about 7 m. correspond very closely with the dimensions of Tr 447. The locations chosen for the two structures are also quite similar.

Tr 446 is located in the arroyo that forms the western boundary of the extensive bordered and terraced fields extending north and south of Tr 341. Because of this proximity, the dam may be associated with the site and its fields. We are, however, again faced with the dilemma of the actual functioning of such a system. Because the dam was constructed at the lower end of the field located north of Tr 341, about the only manner in which water could be removed from the reservoir to irrigate this field would be by hand. Once removed from the reservoir, water may have been distributed manually to the various portions of the field, as no traces of canals were found. Although is is possible that the dam actually serviced the fields to the south, no evidence of this association was observed. No indication of spillways were seen in the remaining portion of the dam and no traces of canals were found leading to the fields just mentioned. It is possible, of course, that the dam was constructed to provide a water supply for the household needs of the inhabitants of Tr 341. Unfortunately, no other dams or water-control features were discovered in the area to shed light on the functioning of Tr 446.

No ceramics or other artifactual materials that could be used for dating purposes were found in direst association with the dam. However, owing to its close proximity to sites Tr 340, 341, 342, 343, 423, and 424, it may be that they were in use at about the same time. The ceramic materials collected from the surface of these sites and nearby fields indicate they were in use throughout in the Venta Salada phase (ca. A.D. 700-1540), and in the case of Tr 342 in the late Palo Blanco subphase as well.

If our chronological estimates of the time of building and use of these two smaller dams are correct, we are faced with the apparent paradox that the first structure of the great Purron Dam may precede them by as much as a millennium. Since its dating rests on quite secure evidence, we suggest that Tr 446 and 447 represent the continuation of a long tradition of sophisticated water-control structures. The preservation and the recognition of evidence for dams depend on many factors, and the absence of firm evidence throughout the Tehuacan Valley for numerous dams from small to large, dating from about the middle of the first millennium B.C. onward, by no means proves their absence. The contrary is more probable, with the impounding and distribution of water for agricultural purposes a highly developed skill playing a crucial role in the expansion of population in the Tehuacan Valley and in the growth of increasingly complex social and community patterns.

The Xiquila Aqueduct

One of the major tributaries of the Rio Salado is the Rio Xiquila, entering from the west about 50 km. south of Tehuacan, and about 5 km. south of the mouth of the Rio Calapilla. It drains a large part of the upland area known as the Mixteca Alta, and is formed by the junction of the Rio Grande de Tepelmeme and the Rio Coixtlahuaca (or Rio Blanco). About 15 km. upstream (southwest) from its junction with the Rio Salado, the Xiquila emerges from a series of deep canyons and enters an area known as Las Huertas (see Comisión del Papaloapan 1954:67-68). For a distance of about 2 km., fertile bottomland borders the river, reaching a maximum width of about 300 m., and supporting a rich growth of such orchard crops as orange, lime, banana, and black sapote. Of great importance to the

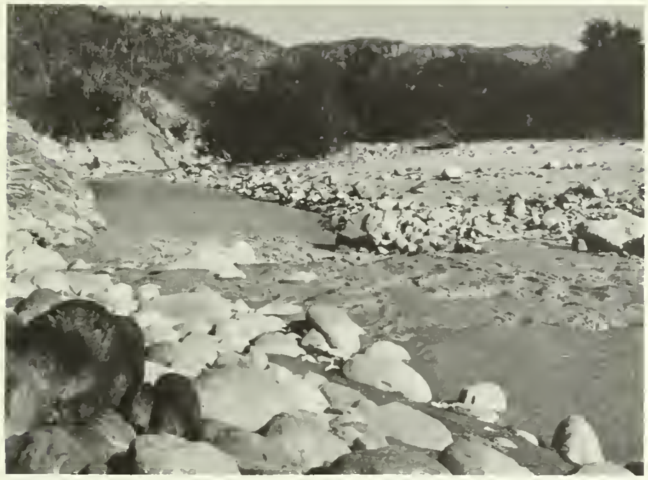


Fig. 16. Rio Xiquila, looking downstream from bank near Tr 405.

regime of the Rio Xiquila is the presence of springs, along this part of the river, issuing from the limestone of the bordering uplands. The Comisión del Papaloapan (1954: 67) reports that in December 1953 during the dry season, the flow of the Xiquila above Las Huertas was only 100 lps (litters per second), but that here it received the following additions: Agua Azul spring (on right bank), 300 lps; Tequelite spring (on left bank), 200 lps; Ojo de Agua spring (on left bank), 500 lps. The river, from this portion of its mouth, had therefore a minimum flow of about 1,100 lps. Two estimates of total flow have been published: *Atlas Climatológico e Hidrológico de la Cuenca del Papaloapan* (pl. 23) gives 280 million cu. m. as determined by measurements at the hydrometric station on the Rio Xiquila; and the Commission's 1954 preliminary report (p. 68) estimated the annual flow as 85,000,000 cu. m. on the basis of the average annual precipitation and the area of watershed as supplemented by the springs mentioned above. The first figure is more reliable, but even the lower estimate indicates a very significant quantity of water available for farming, provided it could be transported to suitable fields.

Below Las Huertas the river flows through a deep valley, the sides sometimes precipitous and rocky and at other points sloping steeply to the hilly country either side (Fig. 16). Here and there small patches of bottomland occur, usually on the inside of bends where the river is cutting on the far side of the channel and depositing on the shallow side. No permanent tributaries add to the flow below Las Huertas, although many small intermittent streams have cut deep little valleys

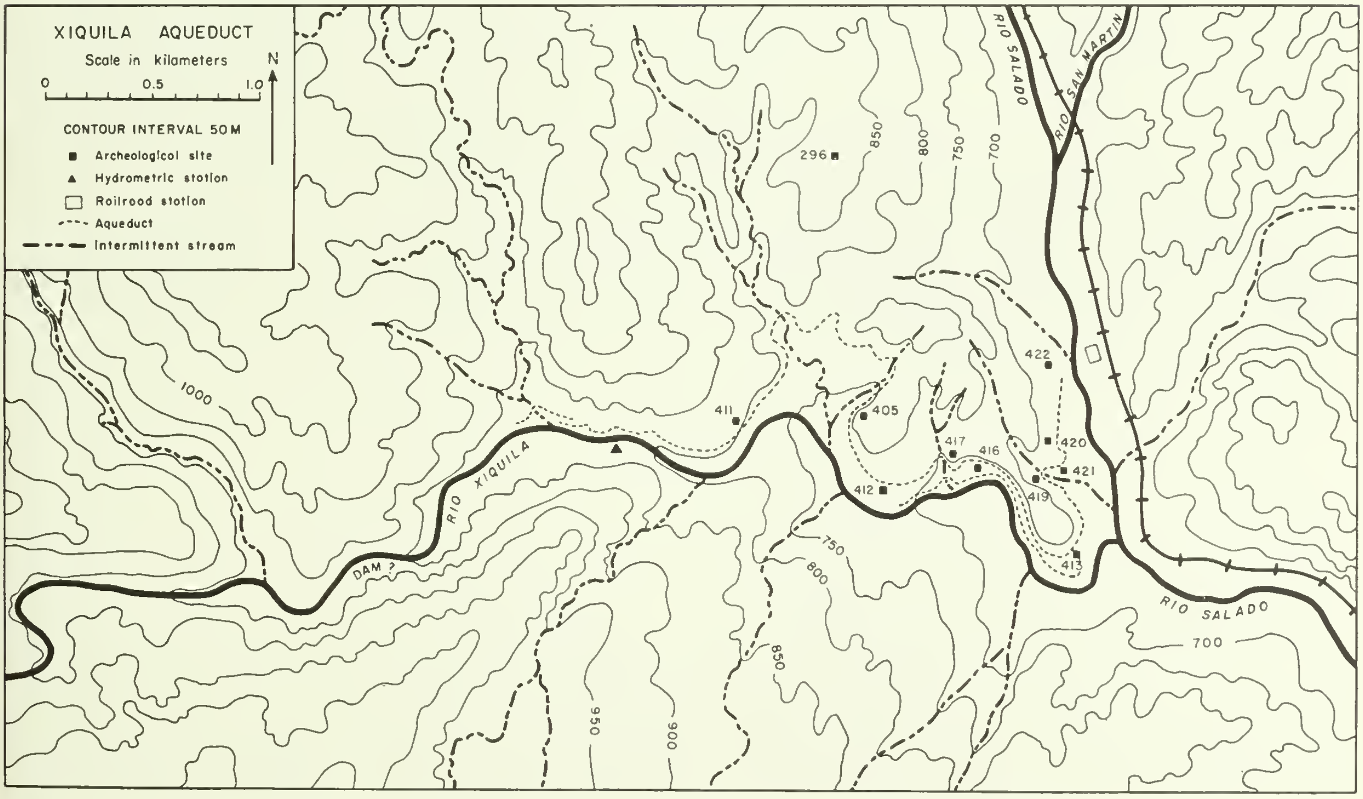


Fig. 17. Map of lower portion of Rio Xiquila, showing location of aqueduct and associated sites.

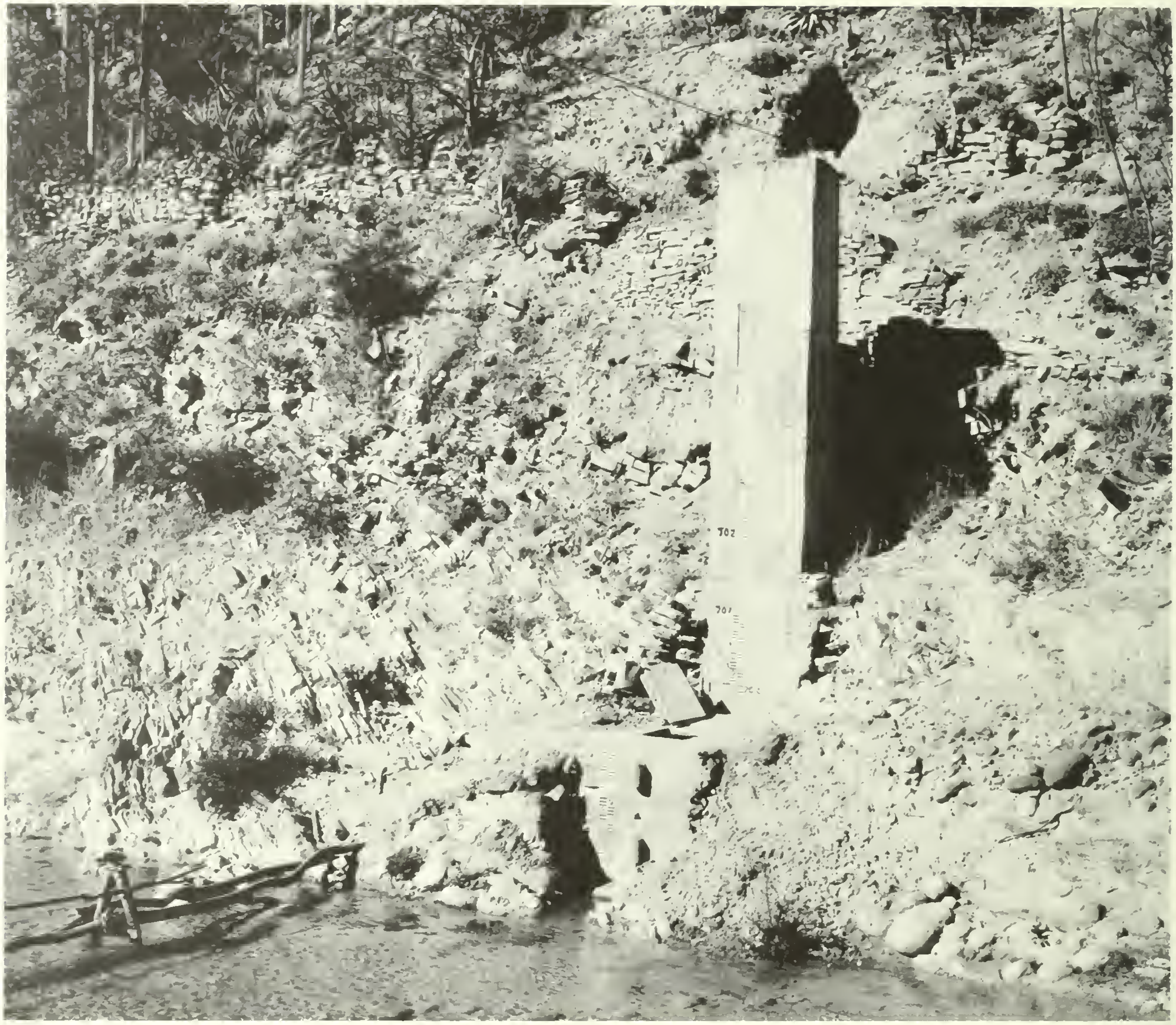


Fig. 18. Masonry of the Xiquila aqueduct, about 12 m. above the stream at the hydrometric station of the Comision del Papaloapan. The original masonry of the aqueduct is visible to the left and right of the top of the concrete shaft; behind the shaft a section has been removed and the stone used to anchor the cable for the car used in crossing to the station during high water.

and during the rainy season may briefly carry large amounts of water. Where it joins the Rio Salado the elevation of the Rio Xiquila is about 680 m. above sea level (estimated from the detailed topographic maps of the Comisión del Papaloapan), having dropped at about 31m/km from Las Huertas to this point.

Traces of a large masonry aqueduct or canal along the Xiquila were observed early in the survey work in the Tehuacan Valley, but until February 1964 no systematic effort was made to determine the nature and extent of the structure. It eventually became apparent that in spite of many gaps where erosion or landslides had obliterated all evidence, a single continuous channel maintaining a fairly even grade had extended from a point about 4.7 km. upstream to the mouth of the Xiquila (Fig. 17). The evidence consists of three kinds of details.

The first and most conspicuous evidence was the surviving portions of a masonry retaining wall, built along steep, rocky sections of the north bank of the

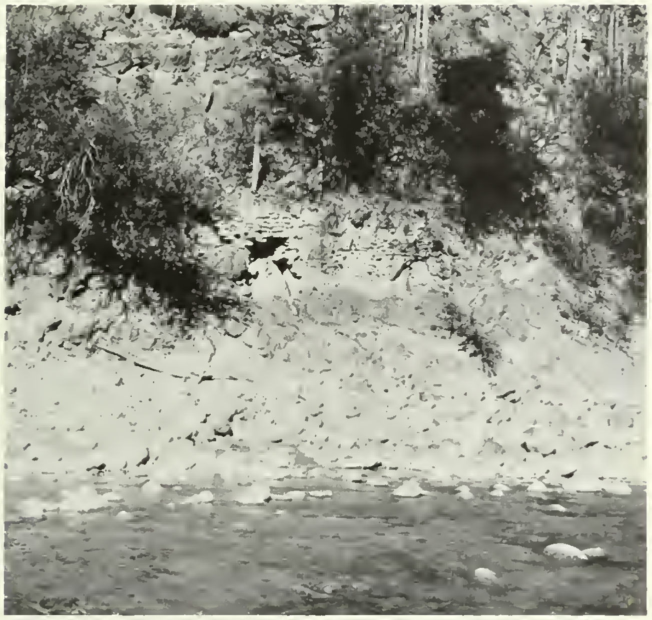


Fig. 19. Masonry of the Xiquila aqueduct near its presumed point of origin, at an elevation of only 5 m. above the dry-season stream level (Feb. 1964).

river. One of the best preserved examples was found well upstream, opposite the hydrometric station of the Comisión del Papaloapan, 0.6 km. upstream from Tr 411. About 12 m. above the stream, at the top of a bare, rocky slope of 60° to 70° from the river and at the base of a nearly vertical cliff, there could be observed a dry-laid masonry wall of some 10 courses nearly 3 m. in height. It extends more or less horizontally for about 50 m., forming a ledge 1 to 2 m. wide (Fig. 18). The masonry is of roughly dressed blocks that could have been obtained easily from the out-crops of fractured and folded sandy limestone just below. An extensive search farther upstream disclosed a few traces of similar masonry, almost entirely eroded away, at successively smaller heights above the stream (see Fig. 19). About 3.5 km. from the mouth of the Xiquila there was a portion of the aqueduct only 4 m. above the stream, at a point where one of the larger intermittent tributaries entered from the north. However, some 15 m. upslope from this location similar masonry could be observed running roughly parallel to the lower wall. The higher channel could be traced only a little further upstream, after it swung away from the river to cross the tributary (see Fig. 17). The possible significance of this abrupt break in elevation of the aqueduct will be discussed below.

Downstream from the hydrometric station, fairly well preserved portions of the masonry retaining wall were found near Tr 405, (see Figs. 20 and 21) and 413, at about 13 and 22 m. above the river, respectively. The latter site overlooks the mouth of the river. Nowhere had it apparently been necessary to build a supporting wall more than about 3 m. high, unless portions now entirely fallen were somewhat higher than this.

The second type of evidence for the path of the aqueduct was found on nearly level locations, such as Tr 416, where the channel had skirted a broad terrace.

Fig. 20. Portions of Xiquila aqueduct on rocky slope near Tr 405.

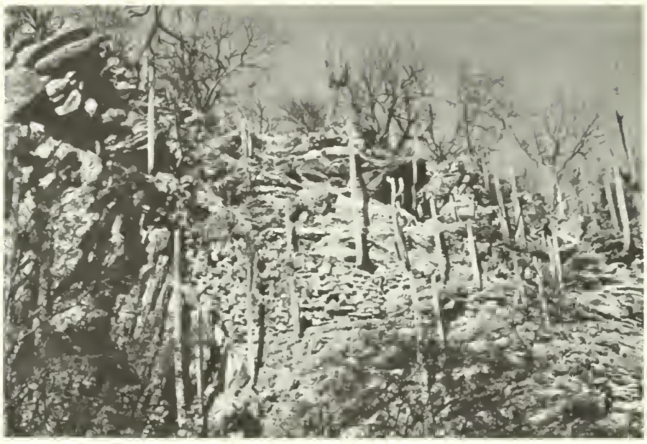


Fig. 21. Xiquila aqueduct skirting the cliff below Tr 405. At left, a ledge was cut into the cliff, and at center a 3-m. high wall was built to carry the channel across a small gully.

Fig. 22. Terrace cut into hillside, presumably to support the Xiquila aqueduct, near its lower end.

Upstream from this terrace the channel had clung to steep slopes and rocky cliffs immediately overlooking the river, but on reaching Tr 416 it swung away from the river and followed the base of the gentler slope that rose from this broad alluvial terrace. At first no trace of the channel could be observed in the dense growth of cactus and thorny shrubs, but by taking a series of sights with a field level to determine the approximate position that a gently sloping channel would have had to follow, we discovered abundant evidence. This consisted of an intermittent line of large boulders (25 to 75 cm. in diameter) marking the lower edge of the channel, curving back and forth along the base of the slope, and with many gaps where either the boulders had subsequently been removed or perhaps were not needed originally to support the channel.

The third kind of evidence was the faintly visible line of the aqueduct, usually observable only from a distance with a favorable light, along some of the less steep slopes bordering the river. Instead of substantial masonry support, a narrow terrace had been cut into the slopes and was now almost imperceptible because of erosion. Its existence resulted nonetheless in a slightly heavier natural vegetation that could be seen from a distance as a faint darkening along the slopes. The only place such a cut was clearly visible at close range was along the hillside between Tr 420 and 421, near the termination of the aqueduct (Fig. 22). This long terrace was discovered at the level at which we had determined any continuation of the channel should be, and since it was not part of any architectural units of the nearby sites, no doubt it was indeed the terrace cut to support the prehistoric channel.

No traces were found of the actual channel that had been supported by the high masonry buttresses or had been held by boulders or on terraces on gentler slopes. To judge from the success with which modern irrigation ditches in the area transport water long distances with no lining, this could have been a simple ditch with earth sides and bottom. Considerable water would have been lost by seepage and to the vegetation that would have crowded the banks, but presumably with an ample supply and a swift flow, sufficient water could have been delivered at the points of use.

In spite of small gaps where no traces remained, the line of the channel can be reconstructed fairly accurately. And in spite of the absence of any evidence of a lining to show the exact width and depth of the original channel, these dimensions can be estimated to have been about 50 to 100 cm. wide and about 50 cm. deep, for a larger ditch could not have been supported along some of the narrow portions of its path.

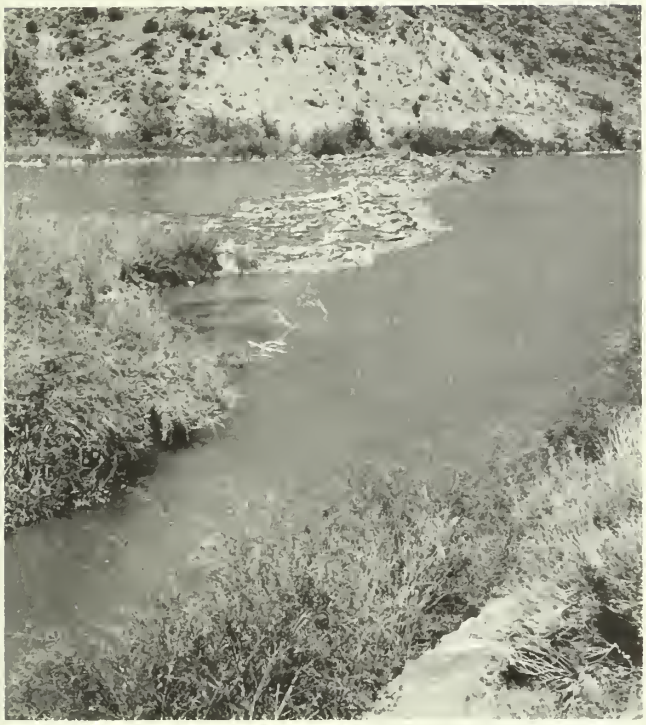


Fig. 23. Modern diversion dam on Rio Xiquila, bringing water to canal at lower left (stream flow is toward left).

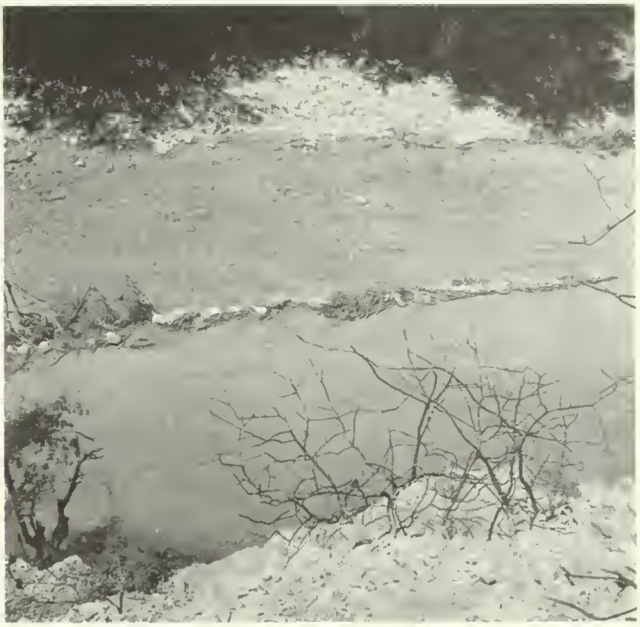


Fig. 24. Upstream end of modern diversion dam on Rio Xiquila.

Although the term "canal" would be equally appropriate for this structure, and is the term we have used for other artificial channels built to convey water throughout the Tehuacan area, we fell into the habit early in our field work of referring to this feature as "the Xiquila aqueduct" and have kept the name here. It is a convenient way of emphasizing the greater elaborateness of this canal, built along the rocky slopes overlooking the Rio Xiquila, in contrast to channels elsewhere that run over mostly fairly even ground.

In tracing the route of this aqueduct, we were unable to find remains close to dry-season stream level at the upper end which would indicate positively the position of the diversion dam that had fed the system. After we had followed the channel upstream to a point about 4 m. above the stream level of Feb.-Mar. 1964, we discovered the higher channel already mentioned, lying about 20 m. above the stream. This channel was observed to end abruptly (see Fig. 17) with no further downstream traces. We could follow this higher channel only a short distance upstream, but if we projected it at the same gradient to a point where it could have left the river, it would seem to have come from the narrowing section of the valley just below Las Huertas. This location was also suggested to us by the men

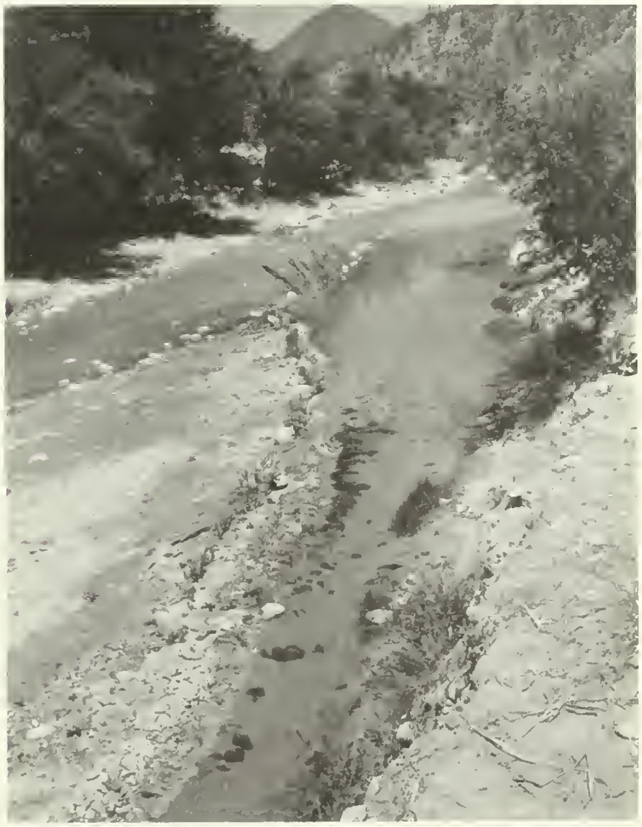


Fig. 25. Modern diversion dam on Rio Xiquila, with beginning of canal in foreground and the brush and rock structure shown in Fig. 24 in background.

on duty at the Comisión del Papaloapan hydrometric station as the location selected for a proposed new dam to provide both electric power and irrigation water. Any diversion dam that may once have existed here would long since have been swept away by floods, and if it was a relatively simple barrier of stones, brush, and mud extending only part way into the stream, as are irrigation dams today on the Xiquila and the Salado, it is understandable that no evidence of it would remain. A large masonry structure across the river, completely damming it, would have been unnecessary, as the diversion was certainly never more than a part of the total flow, even at low water. The diversion dams currently in use in the Tehuacan Valley probably provide our best evidence of the means by which the aqueduct system was supplied.

The low-lying land on the north side of the Rio Xiquila below Tr 412, 416, and 417 is irrigated today by diverting water into unlined ditches by means of rock and brush barriers extending part way across the river and angling sharply upstream (Figs. 23, 24, 25). Very similar structures on the Tlapaneco River, Guerrero, are shown in Armillas, Palerm, and Wolf 1956: fig. 126. Rainy-season floods cause some damage to such structures, but high water would flow over the larger boulders and only remove the branches and smaller stones that are wedged between them in the construction of the barrier. When the water is low, repairs can be made easily with materials close at hand. This type of diversion structure is, of course, essentially the same in rivers in many parts of the world where the entire flow is not needed for irrigation except at the periods of lowest stream flow.

Although the exact location of the head of this aqueduct system can only be estimated, projection of the known portions of the canal and selection of the most suitable topography both lead to the same location, a place about 4.6 km. upstream from the mouth of the Xiquila. The path followed by the aqueduct is of course longer than that of the river, as several long loops were needed up one side and down the other of the larger intermittent streams entering the river. Therefore, from the assumed location of the diversion dam the aqueduct extended about 5.3 km. to where it passed Tr 413, overlooking the mouth of the river; here it turned north and ran for nearly a kilometer more from here, for a total length of 6.2 km.

The elevation of the aqueduct at various points has been calculated on the basis of known elevations along the river derived from the topographic maps prepared by the Comisión del Papaloapan and on careful estimates of height above the river of the better preserved traces. Although the elevations are thus approximations, any serious errors would appear as excessive changes in the grade of the channel. Actually, as calculated, the grade of the aqueduct varies only between 1.3 percent and 3.2 percent except for a short stretch for which 0.7 percent was calculated — possibly an error in our figures but most likely the result of prehistoric miscalculations of the need to circumvent an obstacle in the canyon wall that made the desired grade impossible at this point. Over this entire distance the river drops at about a 4 percent grade, although one stretch about a kilometer long, near Tr 411 and 405, has a steeper grade of about 6 percent, apparently because the stream's cutting has been slowed by some of the hard conglomerate it flows through just above here. Being a youthful stream, it has not achieved a uniform grade.

The abrupt discontinuity in the aqueduct about 1.3 km. downstream from the presumed dam site presents a puzzle. Perhaps the upper channel was built initially at a flatter grade than was necessary to maintain the desired and feasible height above the river; or perhaps a supplementary upstream extension of the channel was built to take water out of the river at a more suitable spot, and the best location along the rocky slopes brought it out above, instead of at, the level of the rest of the channel. We found too little of the upper part of the aqueduct, where the valley narrows and the valley sites become more precipitous, to resolve this uncertainty satisfactorily. At the least, however, the discontinuity in the heights of the two channels suggests that the engineering skill of the builders may have faltered in either planning or execution, although dropping the water some 15 m. down the rocky slope from the end of the upper channel to the beginning of the lower would have been a perfectly successful solution. Today in the Tehuacan Valley irrigation ditches can be seen plunging down steep slopes in channels cut into and built on bedrock, with no appreciable damage to the channel by erosion or loss of water at the lower end (see Smith 1965*a*: fig. 22).

The field study of the aqueduct along the north side of the river brought to our attention, through distant glimpses, a similar aqueduct along the south slopes of the Xiquila valley. Unfortunately, time was too short to trace it out, and it could only be assumed that it was approximately contemporary with the one described above. Estimates of its height above the river suggested that it may have had its source at the same putative dam site.

At a lower elevation on the north side of the river, we found a second but shorter aqueduct which had

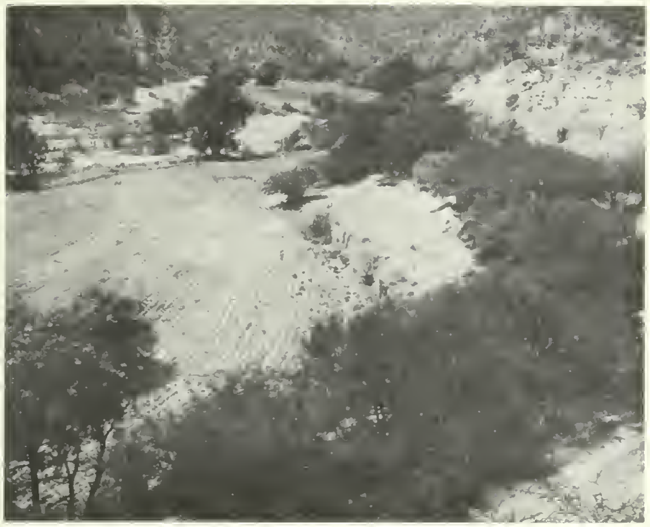


Fig. 26. Modern irrigated fields located along the Rio Xiquila, just below Tr 416 and farmed by men from San Ignacio Mejia.

operated quite independently of the longer one. It took its water from the river southeast of Tr 412; this is close to the spot where a small modern ditch takes water for a narrow strip of farm land along the river. Some sections of this shorter aqueduct also were supported by substantial masonry walls. Its course roughly parallels that of the longer aqueduct, and its total length is about one kilometer. All traces of it end near Tr 413, at a point where the upper aqueduct swings northward to follow a route along terraces bordering the Rio Salado. Judging from its height and position, this second aqueduct could have served to water the land along the lowest reaches of the Xiquila, reserving the water in the other aqueduct some 10 or 12 m. above it for the fields along the Rio Salado, north of its junction with the Xiquila. Thus the two aqueducts could have operated independently and served separate fields. The two canals are so similar in appearance and in details of construction, however, that we at first mistook the lower canal for the termination of the upper canal and were thus temporarily puzzled that after such a long course from high up the river the canal should end so little above it.

There is no question that the two aqueducts are prehistoric, for a series of sites associated with both canals are datable by their pottery to the late Palo Blanco and Venta Salada phases, ranging from about A.D. 400 to the Spanish Conquest. It is improbable that the aqueduct was used during historic times, since no post-Conquest potsherds were associated with the nearby sites. Today the only areas farmed along the route of the aqueducts are on the flood plain of the Xiquila, irrigated by ditches that reach only a few meters elevation above the river and extend no more than 400 to 500 m. (Fig. 26). The men who cultivate these fields do not live close by but come from villages at least as distant as San Ignacio Mejia, the nearest modern settlement, 6 km. up the Rio Salado.

The chronological aspects of the sites associated with the aqueducts are very significant, for most of the Venta Salada sites (Tr 411, 405, and 412) are located upstream and could only be associated with the higher and longer aqueduct. They also may be oriented toward Tr 296, a large fortified hilltop town of late Venta Salada times. The earlier sites, all dating from the late Palo Blanco subphase, are located downstream along the Xiquila or immediately north of it along the Rio Salado and could be associated with either or both aqueducts. One cannot help but speculate that the lower aqueduct was built in late Palo Blanco times and was used mainly during that period, whereas the upper aqueduct may have been built in that period but was used throughout the Venta Salada phase (MacNeish, pers. commun.).

The sites directly associated with the aqueducts are described below. Settlements dating from the late Palo Blanco subphase, starting with the one farthest up the Xiquila and continuing downstream and then northward along the Salado, are as follows (see Fig. 17):

Tr 417 is on a ridge just under one km. upstream from the mouth of the Xiquila. It is situated 4-5 m. above the upper aqueduct and about 50 m. from the river. The site consists mainly of foundations of three to five small rectangular one-room structures and several stone-bordered terraces. Some 25 m. separate this site from its downstream neighbor, Tr 416.

Tr 416 occupies a large terrace about 30 m. above the river. The higher aqueduct curves around behind the site, following the foot of a slope and marked by frequent short lines of boulders apparently placed to support its downslope side. The lower aqueduct passes in front of the site, on the side of the river. About twenty small one-room structures and two artificial earth-and-pebble mounds are grouped along the edges of an area roughly 50 by 200 m.

Tr 413, about 0.6 km. downstream from Tr 416, occupies two fingerlike projections of the canyon wall overlooking the confluence of the Xiquila and Salado rivers. The upper aqueduct courses along the cliff face slightly above most of this site, then curves northward to pass through a portion of the site west of the northernmost promontory. This is the point at which the upper aqueduct swings away from its generally southeasterly course along the lower reaches of the Xiquila to follow a northward route along the Rio Salado. The lower aqueduct passes just below the southernmost promontory, turns northward around its tip, continues several meters, and disappears (perhaps destroyed by erosion rather than coming to an end at this precise point). The site has foundations of about ten single-room houses, some artificial terraces, and a medium-sized platform mound.

Tr 419, about 0.4 km. northwest of Tr 413, lies on a promontory 6 m. above and a few meters west of the northward extension of the remaining aqueduct. It overlooks a lower river terrace and the Rio Salado to the east. A masonry retaining wall surrounds much of a leveled area some 30 by 80 m., on which are foundations of 10 to 15 small single-room houses and a small mound or pyramid.

Tr 420 is about 100 m. north of Tr 419 and occupies a promontory or terrace just a few meters above and west of the aqueduct and overlooking the lower terrace to the east, on which Tr 421 is located. The Salado is some 100 m. away, also to the east. The site covers a terraced and leveled area about 80 by 120 m. and has 5 to 8 small one-room structures and an artificial mound about 15 m. square.

Tr 421 lies on a lower terrace directly east and slightly south of Tr 420, so near that it could be an extension of that site. Several one-room structures and a single platform mound form two roughly parallel rows along either side of the aqueduct, which runs through the site in a northerly direction, its course marked for a distance of about 7 m. by two lines of slabs or boulders set into the ground about a meter apart. The site covers an area about 50 by 80 m.

Tr 422 is about 150 m. north of Tr 420 and 421. It occupies an area about 80 by 150 m., with some houses on the lower terrace occupied by Tr 421 and some houses on the upper terrace occupied by Tr 420 and 419. It is probably the farthest point reached by the longer (upper) aqueduct, all traces of which disappear along the edge of the terrace north of Tr 420 and northwest of Tr 421. There are remains of about twenty rectangular structures, some of larger size than at the other associated sites. The sherds collected from the surface include a fairly large proportion of Venta Salada pottery types, indicating that the site was used in Postclassic times as well as in the late Palo Blanco subphase. The larger structures and the location near the late Venta Salada fortified center, Tr 296, are further indications of this.

During late Palo Blanco times, then, between about A.D. 400 and 700, at least seven small settlements existed along the slopes bordering the Xiquila and Salado rivers. The sherds collected from the sites show, however, that they continued with varying degrees of longevity into the Venta Salada period. Tr 417 and 416 were located on ridges along the Xiquila and the courses of both the upper and lower aqueducts. Tr 413, apparently the termination point of the shorter, lower aqueduct, occupied a double promontory overlooking the mouth of the Xiquila. It was here that the longer upper aqueduct turned north, following a higher and then a lower terrace along the Rio Salado. Tr 419, 420, and part of Tr 422 all occupy outcroppings of the same high terrace. Tr 421 and the eastern part of Tr 422 are on the lower terrace, which would have been a likely location for the prehistoric irrigated fields. The long aqueduct passes northward below Tr 419, crosses an arroyo and turns eastward along it, with its course marked for a few meters by a line of boulders. Then the channel turns north again to pass through Tr 421. Beyond this point, the barely discernible course runs westward along the foot of the slope below the upper terrace, a faint notch cut into the well-consolidated conglomerate that underlies the thin covering of soil (Fig. 22).

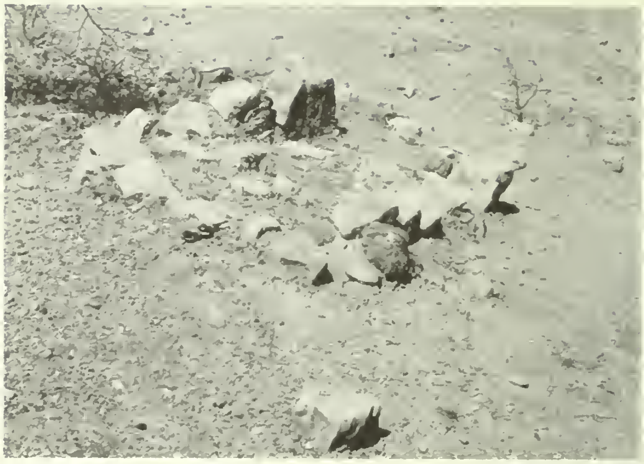


Fig. 27. One-room structure adjacent to aqueduct at Tr 405, which may have served as guard house or maintenance station to protect the aqueduct.

The sites in the area that are limited almost entirely to the Venta Salada phase are, as we have noted, located mainly along the upper section of the longer aqueduct, some distance before the starting point of the shorter channel. These are described in chronological order, since they span both the early and late Venta Salada subphases.

Tr 405 (early Venta Salada) is located on a ridge about 1.3 km. upstream on the Xiquila. It overlooks the long aqueduct, which curves around it on the west and south sides. An area about 50 by 50 m. contains foundations of a pentagonal structure about 8 m. wide and remains of a multi-room structure. A single-room structure, about 1.5 by 2.0 m., is located north of and downslope from the larger buildings and is just above the aqueduct as it passes along the west side of the site. It could have served as a guard or tending station (Fig. 27).

Tr 411 (late Venta Salada) is a small ridgetop site about 0.5 km. up the Xiquila from Tr 405. Piles of building stones are scattered over an area about 30 by 60 m. — perhaps the remains of multi-room houses destroyed by erosion or vandalism. The aqueduct runs along the south slope between Tr 411 and the river, then curves northeastward away from the river to cross the tributary streams separating this site and Tr 405. About 7 m. below the aqueduct and 10 m. below the main part of the site, a small rectangular structure, very like the one at Tr 405, was built on a natural terrace. It measures 1.5 by 2.0 and was constructed of roughly dressed limestone set in clay mortar.

Tr 412 is downstream some 0.8 km. from Tr 411 and less than half that distance from Tr 405. It lies on two levels and consists of traces of multi-room structures or perhaps five or more small structures, plus some foundations lying just below the upper and longer aqueduct and some others located downslope near the first upstream traces of the shorter aqueduct. It is possible that this site is associated both with the late Palo Blanco period, to which use of the lower aqueduct seems restricted, and with the late Venta Salada period, as the sherds collected from the surface indicate.

Tr 296 is a large hilltop center east of the Rio Salado and north of the Rio Xiquila. Though not so near or so closely associated with the aqueduct as the smaller sites along the two rivers, it is close enough and important enough to have dominated the whole area during late Venta Salada times. The site covers not only the top but the flanks of a large hill and contains more sophisticated structures — including fortifications — than those found in the smaller sites.

The Venta Salada sites, except Tr 296, are small, ranging from a few single-room houses to multi-room houses for no more than of a few families. The two single-room structures close to the aqueduct at Tr 405 and 411 may have been for guards or maintenance crews, tending the canal and repairing damage immediately. Any break in the channel not repaired promptly could cause substantial damage, in addition to cutting off water from all the settlements and farms downstream. The Venta Salada villages may have been under the domination — economic, political, or religious — of the builders of Tr 296.

The larger clusters of small houses of late Palo Blanco times probably represent small villages of farmers who used the Xiquila's water for irrigation nearby and cultivated fields on the Xiquila's flood plain or the terraces of the Rio Salado. Tr 416 is especially suggestive of this, as the cultivable land is here immediately adjacent to both canals. The seven sites of this period probably totaled no more than 80 to 100 houses, and if we consider each house to have held one family, this would suggest a quite small population making use of the water for irrigation or household needs. As previously noted, farmers from a village 6 km. away now farm regularly along the lower Xiquila, and there may have been settlements other than those just listed that regularly depended on the Xiquila aqueduct for irrigating their fields. In addition, some of the sites noted may be more extensive than existing remains indicate. However, at the most in any one period only a few hundred families appear to have occupied the immediate area served by the aqueduct.

It would be interesting to know the extent of the area served by the Xiquila aqueduct system in both Palo Blanco and Venta Salada times, but land farmed several centuries ago and unused since does not always leave traces of its use. There are few large, promising areas until the terraces of the Rio Salado are reached, but at many points along the Xiquila small plots of ground could have been farmed, either with water from the aqueduct, or on the flood plain of the river itself by means of small diversion ditches extending a short distance from the stream. Fairly level land along the route of the canal, downslope from it and therefore available for irrigation, totals no more than about 250 hectares (about 625 acres). The addition of sloping land requiring considerable terracing, of which traces were found in only a few places, would no more than double this area, so that it seems unreasonable to estimate the farm land served by the aqueduct as more than about 500 hectares (1,250 acres). The Comisión del Papaloapan has estimated, from its study of the Xiquila, that it has enough water to irrigate 3,000 to 3,500 hectares, more land than is available for farming with gravity-distributed water in the entire district along the Xiquila and Salado. Therefore it is clear that water itself was not as limited as farm land in this area, and only the most intensive agricultural techniques, producing two or three crops a years, would have justified this ambitious prehistoric project.

It may be significant, however, that most of the land that could have been farmed with water from the Xiquila aqueduct had probably not been farmed previously, except by dry farming, with its far lower yields. Bringing into intensive production some 500 hectares, capable of two or three crops a year, would have been worth undertaking, once the engineering problem of getting water to points far above river level had been mastered.

Another question raised by our examination of the Xiquila aqueduct system is how much labor went into its construction. A first impression is that the longer aqueduct especially was an undertaking of tremendous magnitude, possible only with vast numbers of workmen. But a few rough calculations suggest that it may not have been beyond the means of a fairly small group, the villagers of the area immediately adjacent to the aqueduct. Figures on the amount of earth that can be excavated under primitive conditions are difficult to obtain, but as noted above investigations indicate that in the sand and gravel of the Salt River Valley of Arizona a canal builder could move about 1.6 cu. m. of these materials per day (Southworth 1931). In one instance 25 men dug a canal that was about 9 km. long and had a cross-section a meter square, in three years, working only two to three months each year, a total of about 5,600 man-days. The canal along the Xiquila was smaller, probably measuring only half a square meter in cross-section, and approximately one-third of its length would have been fairly easy digging, on gentle slopes with little or no support needed on the downslope side. Thus for about 2 km. of the canal we can estimate 660 man-days. Another third of the canal was in rougher land where digging would have been more difficult and boulders were needed to reinforce the downslope side — perhaps involving about twice as much work, or 1,320 man-days. The remaining third of the canal includes the sections with dry-laid masonry retaining walls 2 and 3 m. high, and places where the bedrock was cut into to provide a foothold along steep slopes. No materials had to be brought in, but the labor could have been at least 10 times as much, or 6,600 man-days for the most difficult 2 km. of construction. On the basis of these rough estimates totaling 8,580 man-days, it would have been possible for the entire longer aqueduct to have been built by only ten men in 858 days, 2½ to 3 years. And a larger working force would, of course, reduce this time.

The observations recorded recently by Erasmus (1965) tend to corroborate Southworth's less systematic conclusions. Erasmus, in an experiment to compare the amounts of earth that could be excavated with a shovel and with a digging stick, determined that with the latter about 2.6 m^3 could be dug in a day (without carrying it away). This is greater than Southworth's figure of 1.6 m^3 and may be the result of the Pima workmen's need to move the earth to the proper location alongside their canal, a requirement that would be paralleled in the building of the Xiquila aqueduct.

If we use Erasmus's figures (1965) instead, the lower estimate of man-days needed would bring the task within the capabilities of the adult men of the several small villages along the canal, perhaps functioning within a local hierarchy or "kingdom" (cf. Spores 1967) with its seat of authority centered at Tr 296. This pattern would have provided the services of a large number of commoners or slaves or both. If such a pattern existed in the native state that included the Rio Xiquila — a pattern which was prevalent throughout the Cuicatec and according to other documentation in the Tehuacan Valley also — it would have been feasible both to plan and carry through construction of aqueducts several kilometers long and also highly desirable to construct them in order to increase the agricultural production that was essential to the traditional needs of a nonagricultural elite supported by tribute. Thus it seems probable, although not demonstrable, that the aqueduct functioned within a tightly-knit hierarchical economic system, controlled by a centralized political system.

If this is a correct estimate of the aqueduct's role and if, as seems most probable, the political system of the entire Tehuacan area was similarly organized, the question arises as to why other aqueducts were not constructed along other streams. The need must have existed widely and clearly the necessary technological competence was available. We have no fully satisfactory answer, but can suggest the following: (a) other aqueducts once existed but all traces have been destroyed by erosion, or such slight traces as do exist went unnoticed or unrecognized in the general site survey, or (b) only the Rio Xiquila provided the combination of large and dependable water supply and an agricultural area that could not be irrigated from springs (as in the upper part of the Tehuacan Valley) or by short canals such as carry water today from the Xiquila to low-lying farms close by. The latter explanation is preferable, particularly in view of the fact that the flow in the Xiquila's lower reaches is substantially augmented by springs, and thus less subject to catastrophic fluctuations from dry season to rainy season. The measurements of stream flow provided by the Comisión del Papaloapan (1956*a*: pl. 23) also indicate the relatively large amount of water in relation to suspended solids in the Xiquila, a reflection of a less violent and fluctuating regime. The accompanying tabulation compares the mean annual flows of the major rivers in the Tehuacan basin, 1926-1955, with liquids stated as millions of cubic meters and solids in thousands of metric tons.

	liquid	*solid*
Rio Xiquila	280	1578
Rio Zapotitlan	28	891
Rio Hondo (Rio Calapilla)	88	1214
Rio Salado (at hydrometric station "Angostura," downstream from confluence with the Rio Xiquila)	300	3800

Thus it may well be that the Xiquila provided the only suitable location in the Tehuacan Valley for diversion of a substantial amount of water for farming during a long season of the year. The hint of an aqueduct or aqueducts on the cliffs of the south side of the Xiquila valley is consonant with this interpretation, and suggests that if such remnants of construction had survived elsewhere they would have been glimpsed in the course of the project's extensive surveys. Nevertheless, it would seem worth examining the steep slopes of small river valleys elsewhere in Mesoamerica for similar pre-Columbian engineering achievements. Structures that wholly lack sculpture, tombs, or accumulated debris of occupation may yet contribute greatly to our understanding of the ways in which man used his habitat in the past.

Agricultural Terraces and Borders

Early in the field work of the Tehuacan Project the staff noted numerous traces of former field systems throughout the Tehuacan Valley and westward into the Zapotitlan area. Many were briefly recorded in the survey files, and we subsequently made a systematic attempt to visit sufficient sites of this type to record details of representative examples. Their number, the difficulty of reaching those in distant areas by jeep or on foot in the limited time available, and the expectation that many of the sites could never be placed chronologically with any certainty, made an attempt to examine carefully all the localities with reported traces of former agricultural systems appear unrewarding. We believe the data presented below exemplify an important type of evidence for past farming activities, without providing satisfactory quantified data on the total extent of the practices involved or a detailed chronological record of the development, spread, and possible decline of this type of farming. As will be discussed below, evidence is often absent for determining when a particular group of fields was in use; many may have been in use quite recently, and some are in use at the present time. They thus are a vivid reminder of the continuity of past and present techniques in man's exploitation of natural resources in the Tehuacan area.

For convenience the individual field systems are grouped into two main types: "valley" systems in which low walls or lines of boulders lie across the intermittent drainage, and "hillside" systems in which walls extend more or less horizontally along the flanks of a hill, often overlooking an intermittent stream. The inference seems reasonable that these structures were built to control the flow of water from rain, by slowing it to increase its penetration of the soil, a technique widely distributed in many parts of the world. In addition, they were apparently intended to reduce soil erosion, which would be increased, otherwise, by the destruction of the natural vegetation incidental to farming. Some of these valley and hill field areas have been in recent use, thus attesting to the local recognition of their effectiveness but adding to the difficulty of determining when a particular system was first constructed.

Hillside Systems

Although the hillside systems of farming plots are based on the same fundamental principles as the valley systems — that is, slowing the movement of water and soil down sloping land in order to retain them for farming — they are located in positions where intermittent stream channels are less clearly defined or there are none at all. It was apparent during the field work that these two categories are merely the poles of a continuum, reflecting the practice of building terraces or boulder lines at any spot where the factors of terrain, water supply, and soil gave promise for successful farming.

Many of the hillside terraces are extensive, but they cannot easily be mapped or measured, as they spread intermittently over the gentler slopes of large stretches of hilly country between the major arroyos. For example, Tr 433, about 2 km. south of Texcala (and overlooking the Arroyo de Atexcala), stretches for more than a kilometer, with stone lines or walls wherever the land received runoff from the higher hills to the west. The lowest wall in a group is often just above a sharp topographic break, where the gentler slope drops off steeply into an arroyo. At Tr 433 the terrace walls were spaced about 20 to 30 m. apart, each wall running approximately horizontally, and thus curving to follow the slope. This site could not be placed chronologically.

Numerous sites of this same kind exist along the

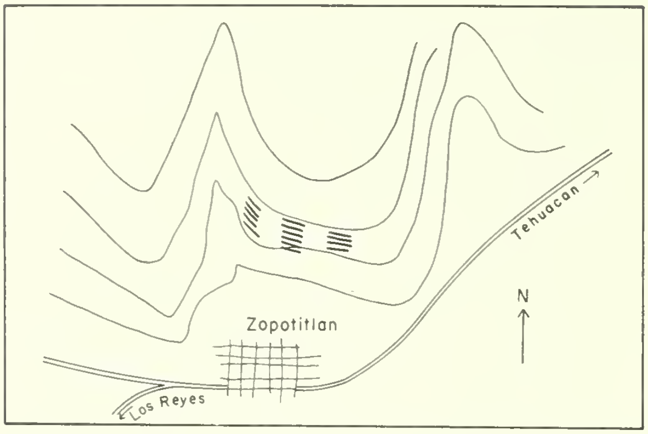


Fig. 28. A hillside farming site, Tr 332 (based on a field sketch, not to scale).

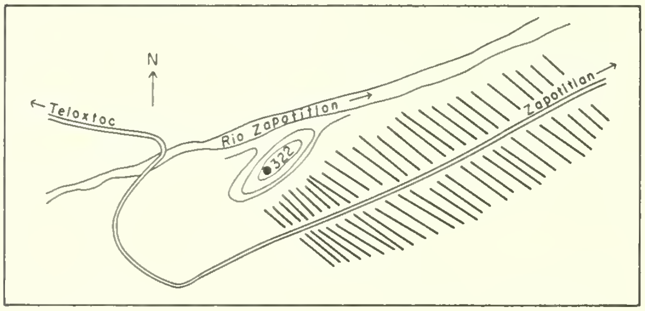


Fig. 29. Farming site on hill flank adjacent to Tr 322 (based on a field sketch, not to scale).

Tehuacan-Huahuapan de Leon highway, from Tr 433 southwest through Zapotitlan and beyond for some 25 miles. We have no reason to doubt that they are not equally plentiful farther from the highway, where lack of time prevented extensive search in all but a few localities. One field system, Tr 20 (late Palo Blanco subphase) has low walls one to three courses high, the longest about 100 m. long and about 30 m. from the next lower wall, others shorter and a little more closely spaced. An unusual detail of this field system is that most of the terrace walls turn up the slope at each end, nearly enclosing the area protected by the walls. The total area of this field system we estimate at 1.8 hectares.

Tr 332 (early Venta Salada subphase) extends intermittently along the middle slopes of the hills overlooking the town of Zapotitlan from the north (see Fig. 28.) Some very large boulders were incorporated in the terraces, probably shifted from close by to reduce the effort of wall building and remove them from the area to be farmed. It is worth remembering, however, that since the prehistoric farming was done with a hoe rather than a plow, farming plots with a few obstructions did not present the problem they do to modern farmers. At Tr 332 erosion subsequent to the construction of farming terraces has probably obliterated parts of the pattern, and no satisfactory estimate could be made of its original extent, although it may have once extended for over a kilometer east to west.

Across the river from Zapotitlan and about 2.5 km. downstream is another large field system, Tr 321, which has about fifty roughly parallel lines of boulders, varying from 10 to 30 m. apart, on a north-facing slope. The area of this system we estimate to be at least 5 hectares and perhaps considerably more. It is assigned to the late Palo Blanco subphase.

Tr 415 (early Venta Salada subphase), located just northeast of Zapotitlan and west of the highway at Km. 22.75, consists of a half dozen boulder lines, each about 75 m. long and spaced about 12 m. apart. These lines run along the flank of the hill in approximately straight lines, but at the end of each there is a short extension angling up the slope and thus inclosing the ends of each plot, as at Tr 20. The total area is about 9 hectares.

One of the largest of the field systems, among the many noted in the area southwest of Zapotitlan, lies across the road to Santa Ana Teloxtoc, on the south side of the Barranca Grande. Tr 322 (late Palo Blanco subphase) includes numerous building foundations on a small hill and a broad area of farm plots to the southeast, on land sloping gently northeastward (Fig. 29). There are at least thirty parallel walls, each averaging about 20 cm. high (Fig. 30) and made up of countless small rocks and pebbles (average diameter about 8 cm.). Most of the terraces are about 100 m. long, and they are spaced about 25 m. apart. The entire area is about 10 hectares. An even larger field system is sketched in Fig. 47-C (locality 1); although this locality was not examined on foot, the area can be estimated as about 24 hectares.

In Tecorral Canyon, where San Marcos Cave (Tc 254) gave good evidence of the transition from plant collection to plant cultivation, there is an extensive series of stone retaining walls, partly taking advantage of the outcropping of flat-lying sandy limestone to create terraces on the steep slopes below the cliffs forming the upper walls of the canyon (Fig. 31). Numerous rock shelters in these cliffs were used to varying extent by past occupants of Tecorral Canyon. The terraces are discontinuous, probably owing to the roughness of the ground, and vary from a single terrace to no more than ten at the downstream limit of this group. In general, the terraces take advantage of the gentler slopes of the canyon and avoid the steeper parts. Individual terraces are 3 to 4 m. wide, but there is little uniformity to them. Although we did not measure each group of terraces, the plots in this series are notably small compared to many of the terraced plots previously discussed. The individual groups of terraces that were measured had areas of 0.1, 0.6, 0.6, 0.8, and 0.8 hectares, and it is probable that the entire canyon had no more than 3.0 to 4.0 hectares of terraced plots. The rather specific clues to the chronological position of these terraces will be discussed below.

Although both the archaeological survey in 1961 and our field work in 1964 gave considerable attention to the Salado Valley from Tehuacan down to Teotitlan del Camino and below, only five farming sites on hillsides were noted. Tr 115 (late Venta Salada subphase) is near Km. 59.50 on the highway, overlooking the Barranca Manzanillo, and consists of an area of about 35 hectares covered with terraces from 8 to 12 m. apart extending around three sides of a low hill. A short distance north an extensive area, not measured, is terraced on the slopes of Loma Larga. The individual terraces average 2 to 4 m. wide and are formed in most cases by single lines of boulders. This site (Tr 86) could not be placed chronologically.

South of Tilapa, on a section of road now abandoned and replaced by a newer highway to the east, Tr 113, an area of about 6 hectares, is terraced but is so disturbed by erosion that the extent of the site is only a rough estimate. Enough sherds were present to assign the site to early Palo Blanco times.

Near Coxcatlan a few field borders were noted, probably of this same kind of hillside terracing, but disturbance has obscured what may have been an extensive site (Tr 164) of either the Palo Blanco or Venta Salada phase.

Tr 447, in the lower portion of Tecorral Canyon, has already been discussed in connection with the dam and the canal system which supplied it (see above, Fig. 14). The field borders are unique, in that each line of stone slabs has a section near one end where boulders apparently permitted easy opening and closing of the water channel to the next lower terrace. These presumed openings were approximately in line with each other, so that lower terraces were bypassed. Tr 447 was probably built and used in late Palo Blanco times.

There are satisfactory measured or estimated area determinations for only fifteen of the hillside field systems. They are distributed as follows:

less than 1.0 hectare, 5 fields
1.0- 1.9 hectares, 1 field
2.0- 2.9 hectares, none
3.0- 3.9 hectares, 1 field
4.0- 4.9 hectares, none
5.0- 5.9 hectares, 1 field
6.0- 6.9 hectares, 2 fields
7.0- 7.9 hectares, none
8.0- 8.9 hectares, 1 field
9.0- 9.9 hectares, 1 field
10.0-10.9 hectares, 1 field
11.0-23.9 hectares, none
24.0-24.9 hectares, 1 field
25.0-34.9 hectares, none
35.0-35.9 hectares, 1 field

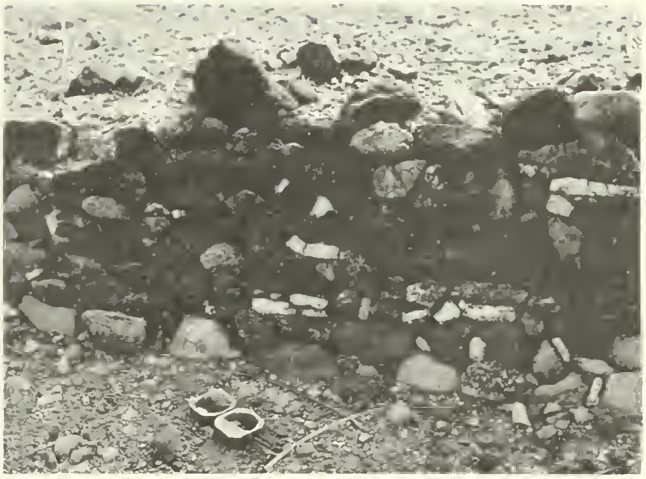


Fig. 30. A wall at farming site Tr 322, about 20 to 30 cm. high.

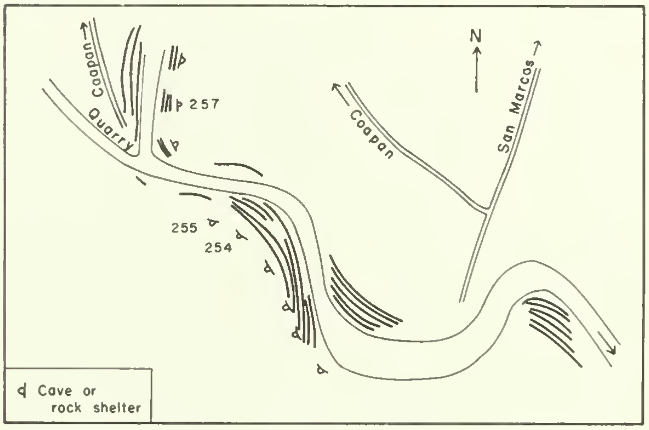


Fig. 31. Farming sites in Tecorral Canyon (based on a field sketch, not to scale).

Compared with the valley field systems, the hillside systems are more varied in size, with a few very small and two very large. Their average is 7.3 hectares (about 18 acres), which is roughly twice the average size of the valley fields. However, the small number of fields for which even estimated dimensions are available and the lack of any systematic procedure for avoiding bias in the sample makes it doubtful that these comparisons are more than suggestive at best.

On the basis of sherds found in apparent association with hillside farming areas, particularly with traces of presumed field houses in some of them, it was possible to assign twenty-seven of these sites to a chronological position. Such an assignment was rarely as certain as we would wish, but we feel it is indicative in at least a general way of the span of use for these farm areas. Three sites (Tr 113, 254, and 275) are of the early Palo Blanco subphase, and ten sites Tr 20, 255, 257, 258, 260, 318, 321, 322, 335, and 344) are of the late Palo Blanco subphase. Five sites (Tr 261, 332, 334, 336, and 415) are of the early Venta Salada subphase, and nine sites (Tr 115, 310, 315, 316, 323, 324, 329, 337, and 350) are of the late Venta Salada subphase. Thus, from a start in early Palo Blanco times, hillside farming systems show a continued and substantial use to modern times. There are no valley systems as early, and in late Palo Blanco times valley systems are only one-half as numerous as hillside systems. In Venta Salada times the two types are about equal in number.

The group of fields in Tecorral Canyon presents particularly interesting chronological problems, because of the relatively close association of the farming plots and the occupied rock shelters overlooking them. Vegetal materials in the rock shelters (particularly San Marcos Cave, the most productive site of the canyon) indicate that during Coxcatlan and Abejas times plant-collecting was still basic in the subsistence pattern, but small amounts of corn were being grown as well as squash and gourds. Fields were probably in the small flat-lying areas alongside the bed of the intermittent stream. Although small in size and constantly threatened by stream damage, they would have been well watered and highly productive without extensive irrigation or terracing.

During the Palo Blanco phase the archaeological evidence from the caves in the canyon suggests that occupation lasted through the summer, when a variety of crops were planted, tended, and harvested. The building of terraces in order to farm the slopes as well as the stream bottom probably dates from this time. Sherds collected in small amounts and in association only with the most southerly of the terraces on the west side of the canyon suggest at least a limited use of these farm plots into the Venta Salada phase. Where the farmers were living cannot be determined. Although the association of farm plots and occupied rock shelters might seem to provide for Tecorral Canyon a relatively sure clue to the archaeological phases during which it was exploited for farming, there remains the uncertainty of cultivators possibly coming from villages some distance away from the canyon.

Valley Systems

One of the better preserved and more easily observed valley farming sites, Tr 314-north, lies on the west side of the Tehuacan-Zapotitlan highway at Km. 13.38, about 2 km. south of Texcala. It is located near the head of a small barranca, where it is relatively shallow and broad. In this cirque-like basin prehistoric farmers built linear borders, ranging from about 8 to 30 m. long, at right angles to the channel into which the sheet wash from the surrounding slopes intermittently drains. These borders run approximately north-south, and the stream flow is eastward (see Fig. 32). In 1964 sixteen well-defined parallel stone structures could be seen, and since the eastern part of the site is extensively eroded, there originally may have been more (Fig. 33). The terraces of this system stand from 30 to 170 cm. high, the majority of them over 75 cm. They are built of unmodified cobbles and boulders cemented into place with an adobe-like mortar (Fig. 34). Individual stones range in diameter from about 10 to 70 cm., the average being about 25 cm. These low walls were built to the edge of the intermittent channel that runs through this basin, and some of them were joined by low walls parallel to the channel, apparently to reinforce them at the spot where the threat of damage by erosion was greatest. Where such reinforcement is absent, its lack may reflect the modern use of this site as a convenient source of building material for the nearby highway.

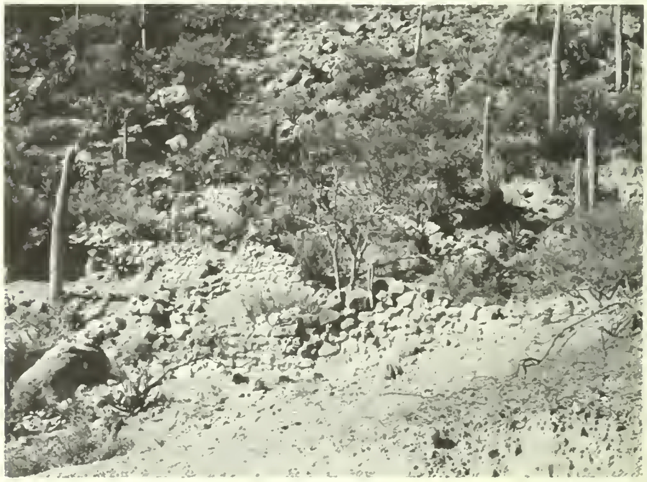


Fig. 32. Farming terraces (Tr 314-north) across a small intermittent stream.

The system of terraces, as it now stands, covers about 3,000 sq. m., and it is possible that an area as large or larger has eroded away at the lower end. An oval or circular structure is associated with the system of terraces near its eastern end. The structure is about 3 m. in diameter and at the north side has an entry (?) formed of large flat slabs set on edge at right angles to the wall. Another opening may have been built in the south wall. The purpose of this structure is unknown, but is could have served for storage or as a field house or temporary dwelling. It is also possible that its association with the field system is fortuitous.

About 25 m. south of the southern bank of this basin are the remains of four small structures, each about 2 by 2 m. The sherds found with these structures as well as among the terraces placed them in the late Venta Salada subphase.

The head of the next small barranca to the south contained a similar field system (Tr 314-south), extending a little farther downstream, but differing in no essential details. It covers about 4,800 sq. m. or a little more than an acre. The sherds found place it in the late Venta Salada subphase also.

A similar site of the same phase but more seriously damaged by erosion, adjoins the Tehuacan-Zapotitlan highway at Km. 12.50, about one kilometer south of Ts 314. This site (Tr 313) consists of an upper and a lower portion (see Fig. 35), each cut deeply into by recent channel erosion. Numerous very large boulders lying on the area cultivated were incorporated into the terraces; it is doubtful that they were moved any great distances (Fig. 37). The terraces are built of cobbles and smaller boulders, and range in height from 15 to 65 cm., with most of them less than 45 cm. (Fig. 38). A higher wall (maximum 1.5 m.) parallels the arroyo at one point. The group of terraces at the south, facing northeastward, covers about 150 sq. m. of cultivable land; the central group about 3,500 sq. m.; and the northern group, on a higher level, about 2,500 sq. m.

In the upper terraces of the central group were several small structures that we believe were designed to minimize the damage from heavy runoff. These "runoff boxes," as we have called them, are of two sorts: Type A (Fig. 36) consists of a small rectangular step built out from and below the top of the terrace, presumably to catch water pouring off the terrace and prevent it from undermining the wall. It is filled with small stones, and the boulders of which it is built average about 40 by 60 cm. in size. The other kind of structure, Type B (Fig. 36), consists of a similar step, set back into the terrace, and is built of stones about 15 to 30 cm. in diameter, smaller than those in the terrace. It

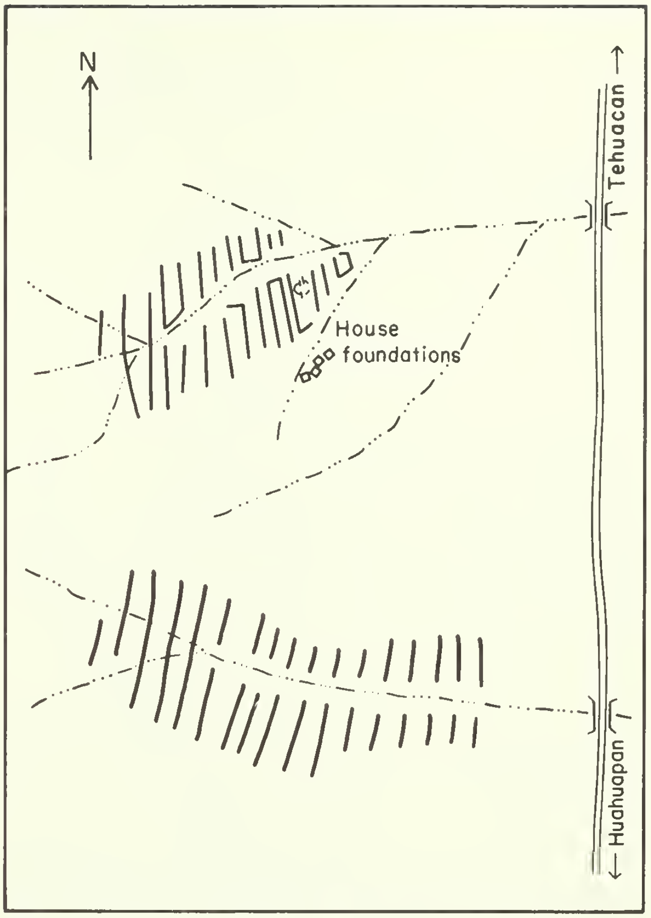


Fig. 33. Farming terraces (Tr 314) built in a small, steep canyon (based on field sketch, not to scale).

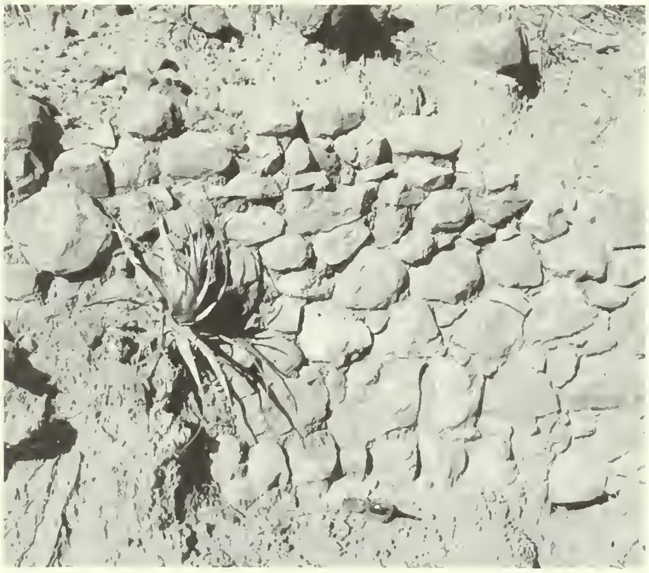


Fig. 34. Terrace walls at farming site (Tr 314-north), built of boulders and cobbles with adobe mortar, about 1.2 m. high.

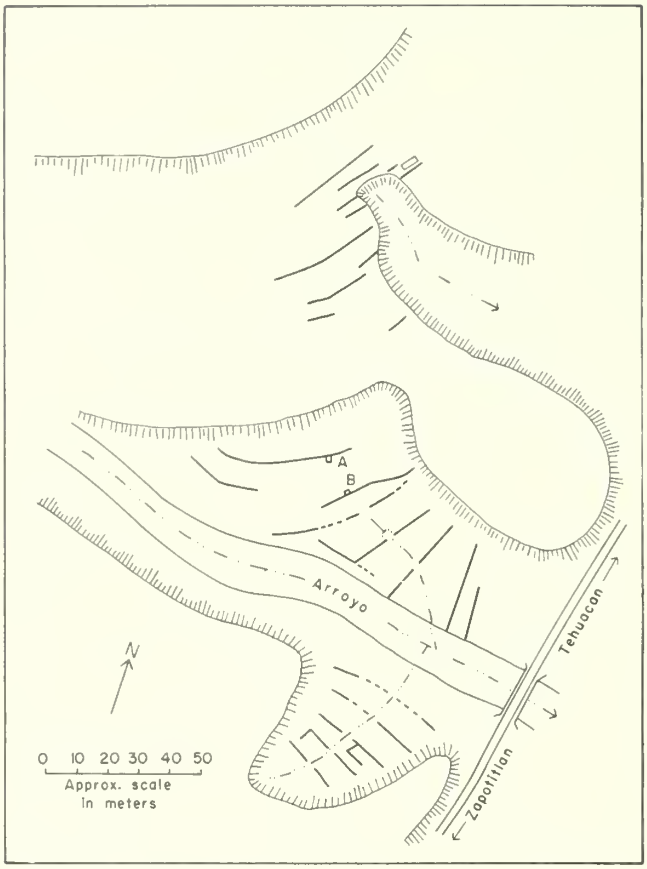


Fig. 35. Farming terraces, Tr 313, built on two levels. A and B are "run-off boxes," shown in detail in Fig. 36 (based on field sketch, not to scale).

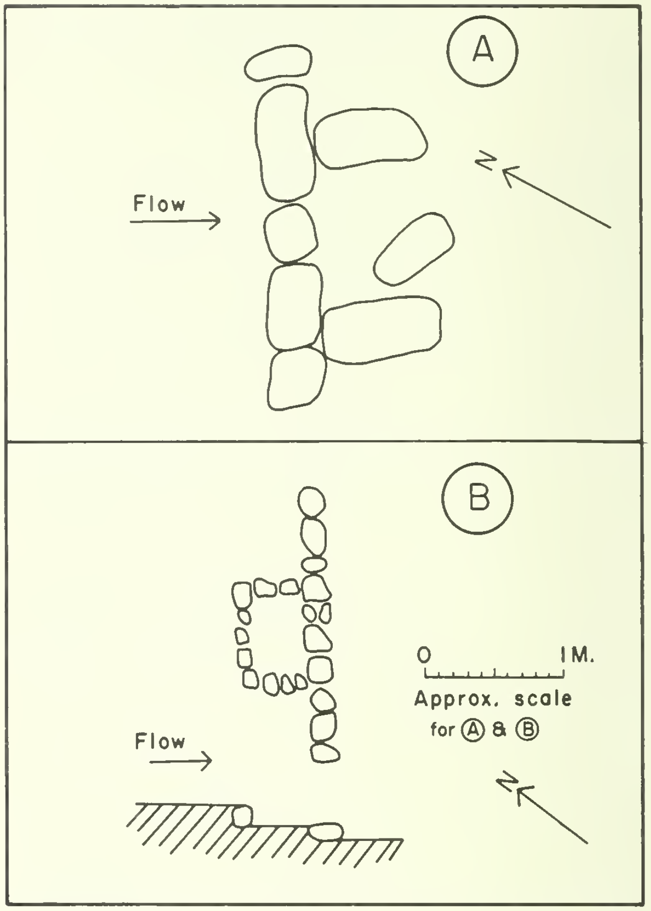


Fig. 36. Sketches of "run-off boxes" at Tr 313, presumably built to minimize erosional damage to the farming terraces.

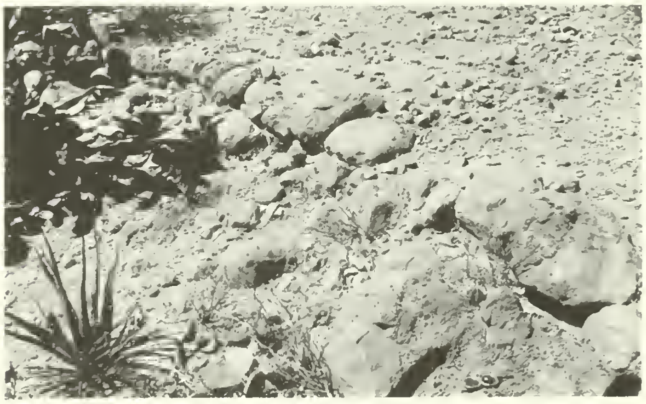


Fig. 37. The uppermost boulder terrace of Tr 313, using large boulders which were probably moved only short distances, interspersed with smaller stones.

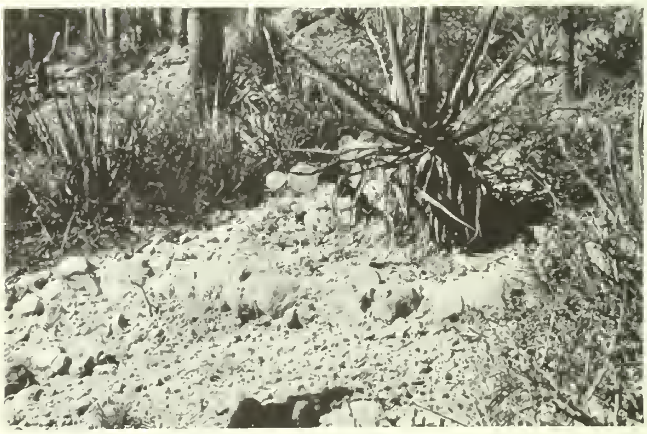


Fig. 38. Row of boulders forming field border or low terrace at Tr 313.

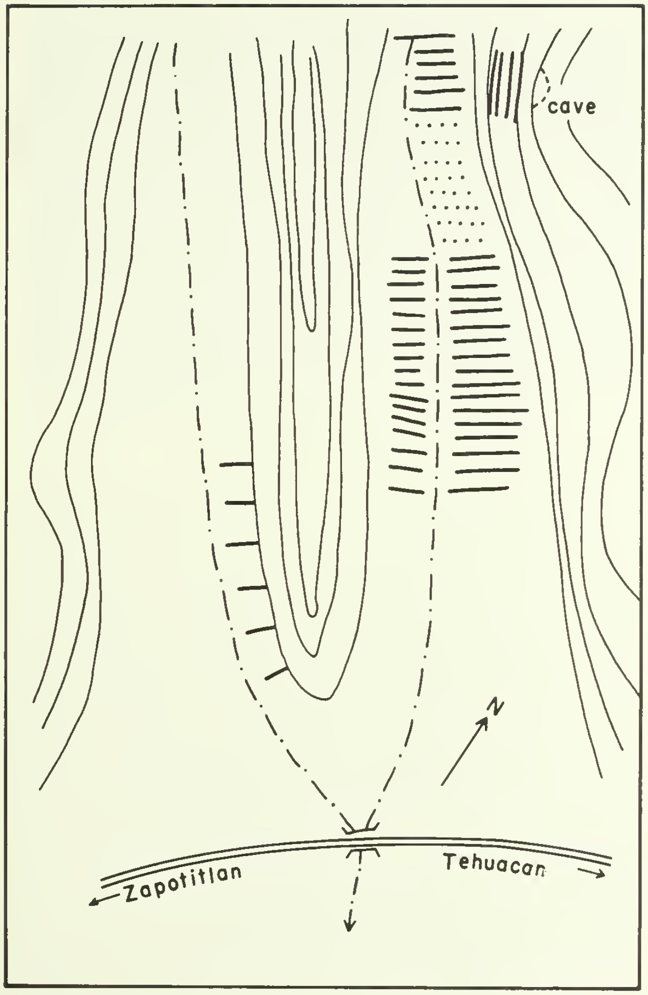


Fig. 39. Boulder lines marking prehistoric farm plots at Tr 317 (based on field sketch, not to scale).

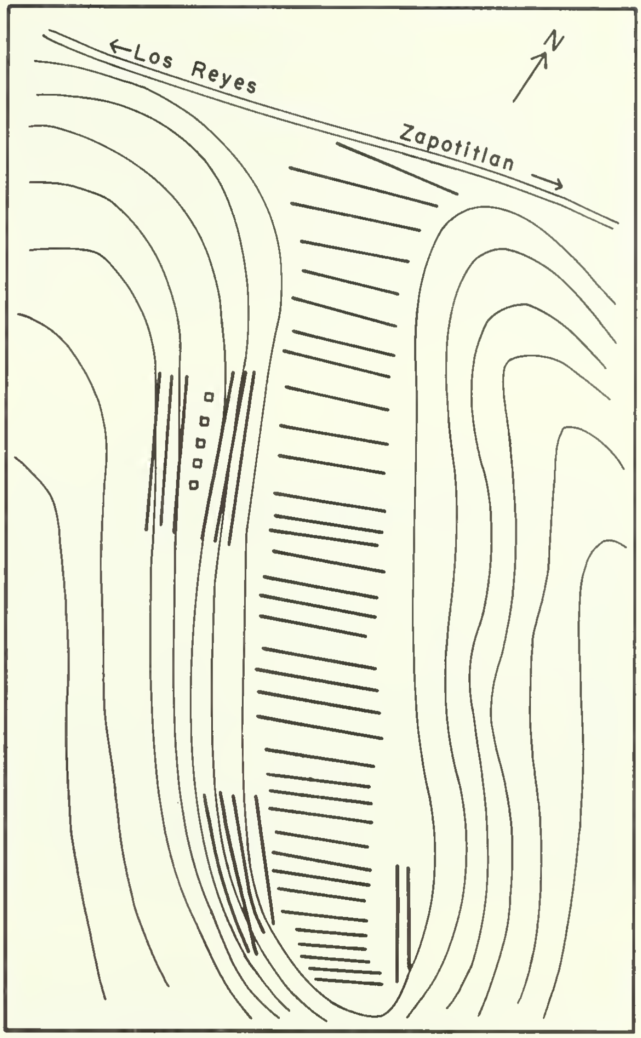


Fig. 40. Boulder lines at Tr 330, a farming site (based on field sketch, not to scale). Several house foundations lie among the terraces on the south slope.

too is filled with small stones. The next three terraces downslope may have had similar "runoff boxes" but recent erosion had damaged them too much for this to be certain. Traces of such arrangements were observed at Tr 314 and elsewhere, but the remains were never well enough preserved for the details noted here to be recorded.

Associated with the northern part of Tr 313, which has been deeply cut by a modern gully, was a small rectangular structure, 1.2 by 1.0 m., consisting of a single course of cobbles without certain evidence for having stood any higher in the past. It lies between two terraces toward the northeast limit of the site, and its function is unknown.

At Km. 18.50 on the Tehuacan-Zapotitlan highway lies Tr 317 (Fig. 39) consisting of (1) a group of small boulder lines, possibly modern, lying just below a small rock shelter, (2) an extensive group of stone lines lying across the intermittent stream draining a long narrow basin running southeast toward the highway, and covering an area about 250 m. long by 50 to 100 m. wide (an area estimated at 14,000 sq. m. or nearly 4 acres), and (3) traces of a similar but more widely spaced series of boulder lines part way across the basin a short distance to the southwest. This last area would have provided an area of farmland two or three times greater than the preceding, if our surmise is correct, in the absence of clear evidence, that boulder lines once covered this basin also. On the same slope as the rock shelter, a short distance east of the four-acre field system, traces remain of a single-room structure (1.5 by 2.0 m.) built under the edge of a large boulder

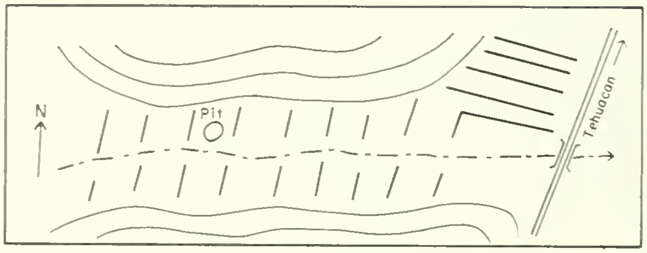


Fig. 41. Boulder lines at farming site Tr 414 (based on field sketch, not to scale).

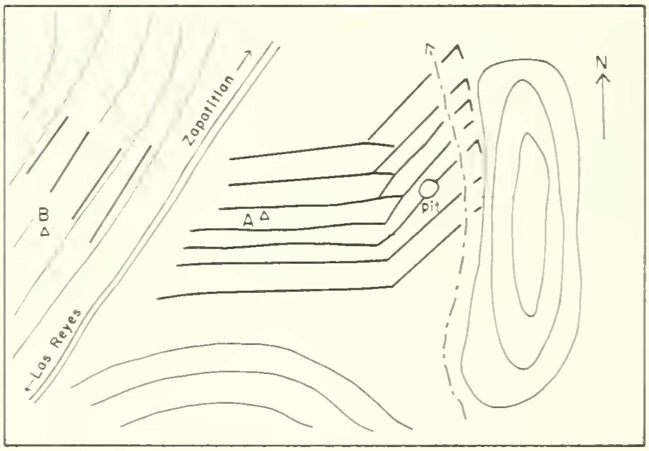


Fig. 42. Sketch map (not to scale) of boulder terraces at Tr 418. Concentrations of sherds at localities A and B probably came from former field houses of perishable materials.

slumped from the higher land to the eastward. As at other farm sites, such a structure might have served both as an overnight shelter during the farming season and as a temporary storeroom at harvest time.

About 3.5 km. southwest of Zapotitlan the road to Los Reyes Metzuntla passes west of Tr 330, known locally as Mogote del Tablar and also as Chulavista. The stone borders lie across a narrow, shallow canyon draining northwestward and are spaced about 10 to 30 m. apart (Fig. 40). On the slopes of the canyon lie additional field borders, a single boulder high. Among those on the southwest are foundations of at least five masonry structures, the smallest about 2 by 3 m. and the largest about 3 by 5 m., each of them probably a single room. The effectiveness of these borders, particularly those across the basin-like canyon floor, in holding the scanty moisture, is indicated by the fact that vegetation today is concentrated along the stone lines. An alternative or additional explanation is that recent re-use of this farm land has cleared vegetation from all but the boulder lines; nevertheless, this relatively concentrated vegetation, in an area of noticeably sparse growth, suggests that the moisture-control system is continuing to function. Tr 330 is assigned to late Venta Salada times.

Tr 414 (see Fig. 41) lies on the west side of the Tehuacan-Zapotitlan highway at Km. 18.90. Two groups of boulder lines, at approximate right angles to each other, lie across the flow of the intermittent drainage of a small basin. A deep clay-lined pit, its walls hardened by firing, was noted close to the eroded main channel of the site; the pit is about 1.5 m. in diameter and 3.0 m. deep, with an opening (a ventilator?) exposed in the wall of the nearby stream channel. It is doubtful if this pit is related to the farming site, which classification of the sherds places in the early Venta Salada subphase.

About 2.2 km. southwest of Zapotitlan, the road to Los Reyes Metzuntla passes through a shallow basin drained by an intermittent stream flowing northward (see Fig. 42). Tr 418, of the early Venta Salada subphase, includes three sets of terraces. (1) West of the road terraces are only a single boulder high and are difficult to trace. (2) Across the small arroyo on the east side of the basin the terraces are now cut by the stream channel; several of them turn at their eastern end and run back along the foot of a small hill, as though to prevent runoff from it from penetrating directly onto the terraces. (3) The center of the site has seven terraces built of mixed large boulders and cobbles, spaced about 15 to 20 m. apart. At the lower end of the area they stand from 50 to 75 cm. high (Figs. 43, 44) but at the top of the slope they are only a single stone high. The two main lines of terraces meet and join, as seen in the sketch plan. We estimate that the area of farmland represented by the system was about 60,000 sq. m.

One of the terraces crosses the remains of a pit about 2.5 m. in diameter and 2 m. deep, lined with stones set in adobe mortar, and probably antedating the use of these fields (or at least their latest use). At two locations (A and B on Fig. 42) there were concentrations of early Venta Salada pottery types, suggesting that formerly small structures of perishable material (pole and thatch?) may have stood here, possibly field shelters for use during the busiest time of the growing season. Such structures may be seen today on the edge of corn fields in the Tehuacan Valley (Figs. 45 and 46).

About midway between San José Tilapa and Teotitlan del Camino lies Tr 111, consisting of several small clusters of early Venta Salada building foundations, and in a small, shallow valley below them many

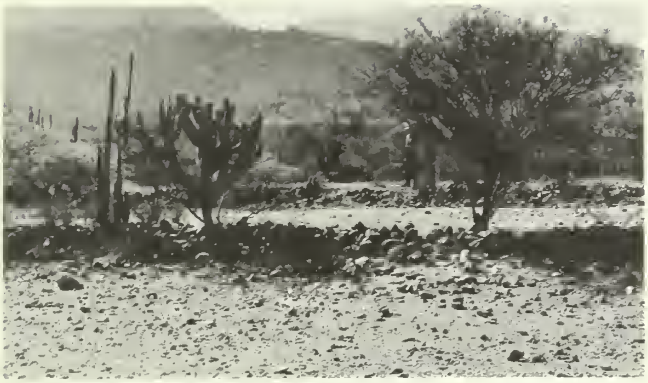


Fig. 43. Boulder terraces of farming site Tr 418.

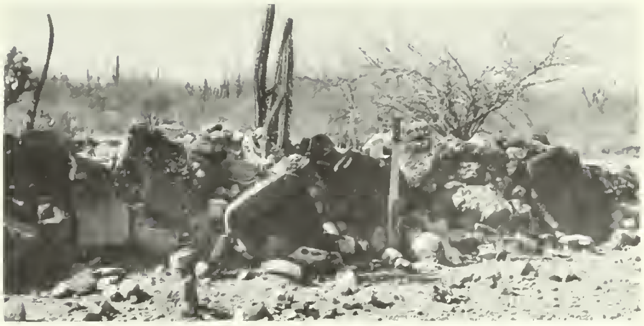


Fig. 44. Boulder terrace at farming site, Tr 418, showing large and small stones roughly piled together.

long parallel lines of boulders covering an area of at least 50 by 150 m. (7500 sq. m.).

Tr 172 is similar in layout. It is located about a kilometer south of the small settlement of Axusco, which is located on the Rio Zapotitlan near the Rio Salado, and consists of several clusters of house foundations overlooking a broad, shallow arroyo draining eastward and containing at least fifty low boulder terraces. The terraces average 150 m. in length and are spaced about 6 to 10 m. apart. The area thus controlled is about 60,000 sq. m. (about 6 hectares or 15 acres). At least two small one-room foundations occur among the boulder lines. Most of the sherds found in this area were associated with these foundations or with several small (artificial?) mounds which may have supported structures of which no traces remain. The site belongs to the late Palo Blanco subphase.

About 7 km. south of Axusco, on the west side of the road to the Rio Calapilla, there is a large salt works, Tr 196, dating from early Venta Salada to modern times; apparently associated with it is Tr 197, a field system consisting of forty to fifty boulder lines about 100 m. long and spaced 5 to 10 m. apart, across a small intermittent stream running south. The site is badly eroded, sherds were scarce, and the extent and details of the structures were difficult to observe because of heavy xerophytic growth. The area over which moisture and soil movement were controlled is estimated at about 40,000 sq. m. (about 4 hectares or 10 acres).

Eleven other sites (Tr 326, 327, 340, 341, 342, 343, 346, 423, 430, 431, 432) of this general type were found in a far-from-exhaustive examination of the area south of Zapotitlan along both the main highway to Huahuapan and in the locality known as Agua del Mixteca (about 2.5 km. south of Zapotitlan). Since

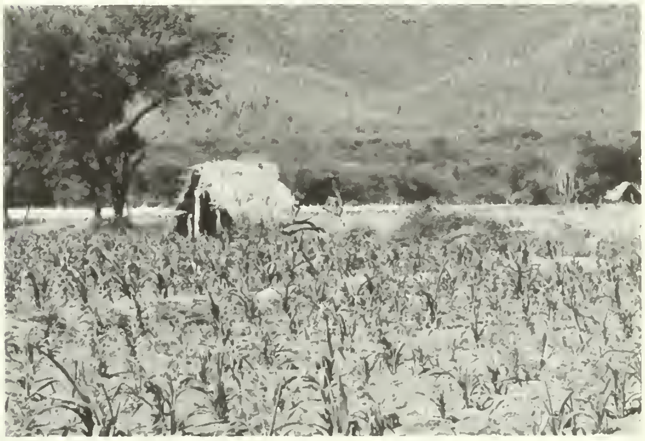


Fig. 45. Modern "field houses" at the edges of irrigated corn fields north of Pueblo Nuevo.

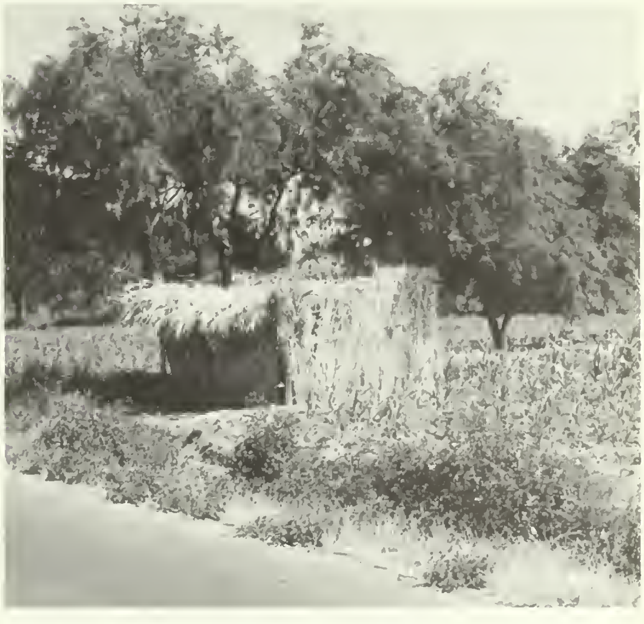


Fig. 46. Modern "field house" at edge of corn field, just north of Pueblo Nuevo.

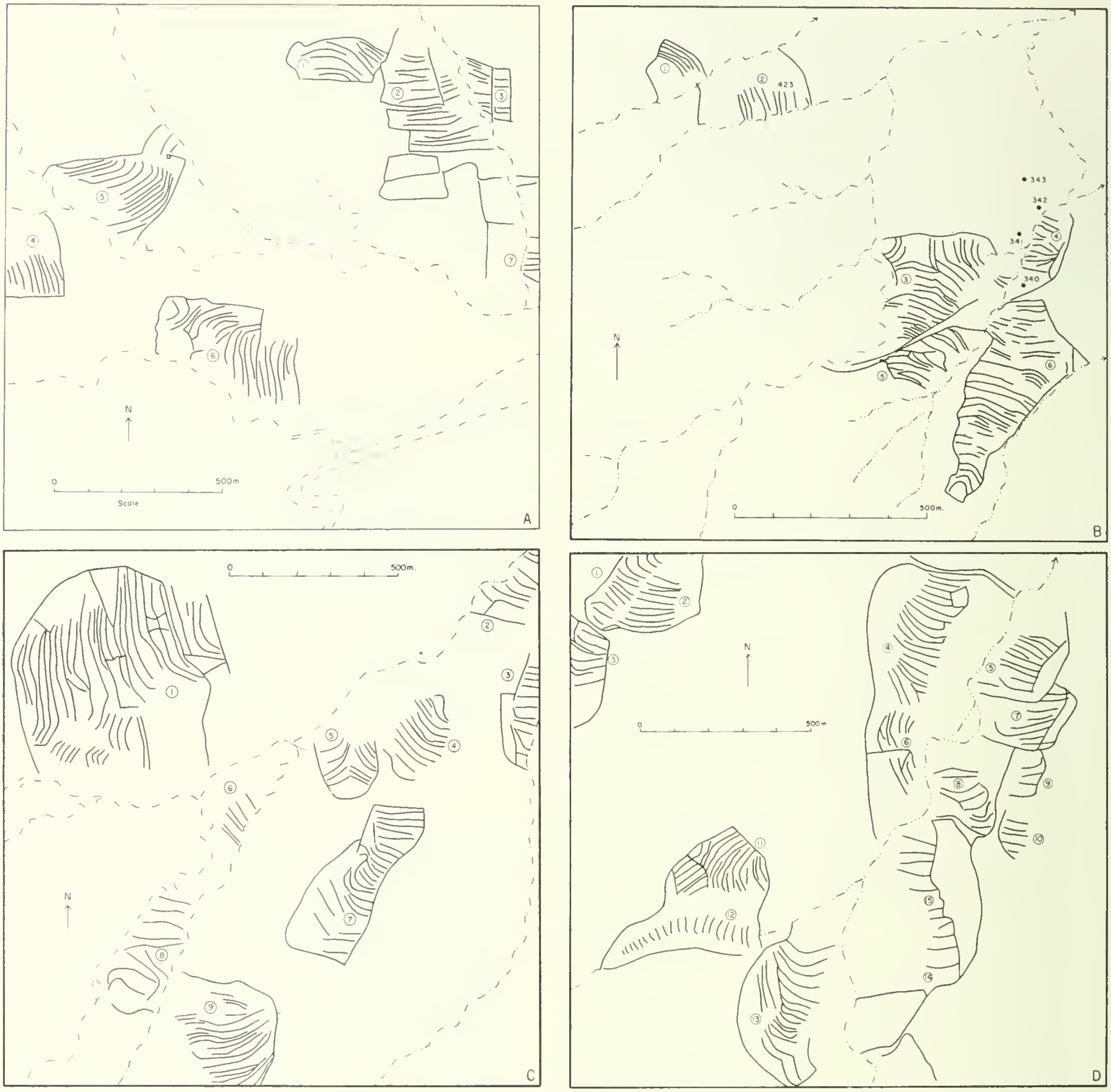


Fig 47. Field systems southwest of Zapotitlan, traced from air photos of the Comisión del Papaloapan. Scale is approximate. [A is from photo 6582; B from 6606; C from 6608; and D from 6610.]

they conform to the general pattern details have not been reported for them individually. They range in time from the late Palo Blanco to the late Venta Salada period, but three could not be classified.

In order to supplement the examination of field systems accomplished by truck and on foot, we examined the aerial photographs on file at the Tehuacan Project office. Visits to a few of the field systems visible on the photographs and studies of the evidence on the ground convinced us that at least our general impressions from the photographs were correct. The photographs studied in some detail (xxiv-j C.R.P. 6582; xxiv-k C.R.P. 6606, 6608, and 6610) covered the area west-southwest of Zapotitlan, where both hillside and valley field systems were particularly numerous. Tracings of small sections, greatly enlarged,

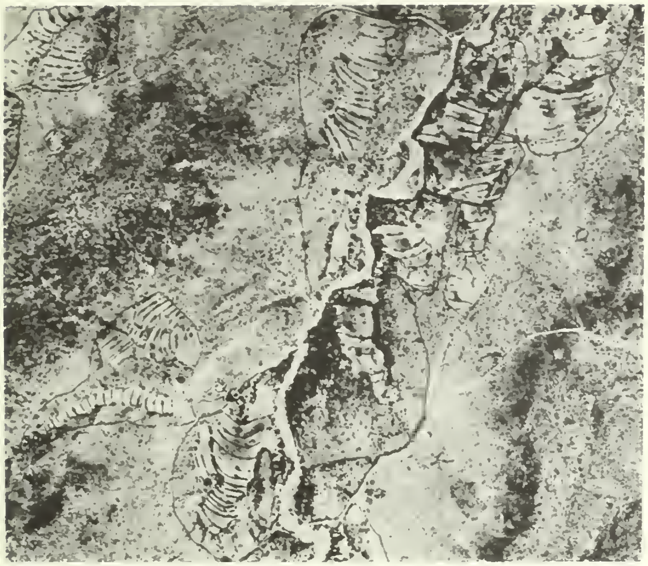


Fig. 48. Portion of the air photo from which Fig. 47-D was traced. The area shown is about 1.6 by 1.6 km.

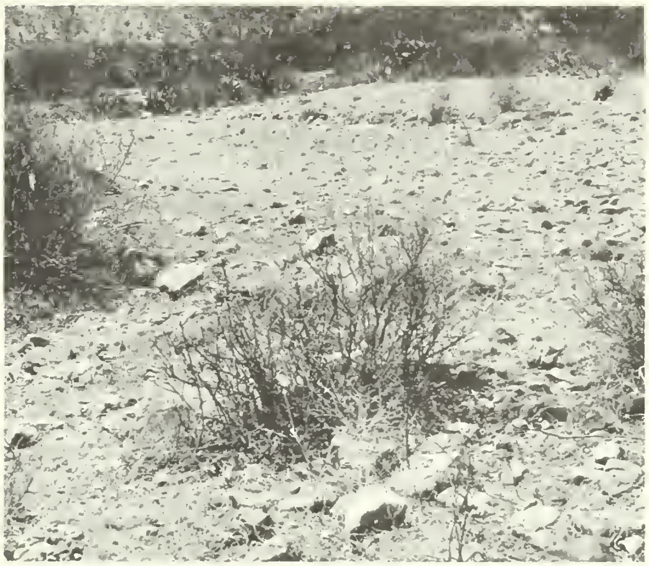


Fig. 49. Boulder borders in upper part of field at Tr 423, which also appears in Fig. 47-B.

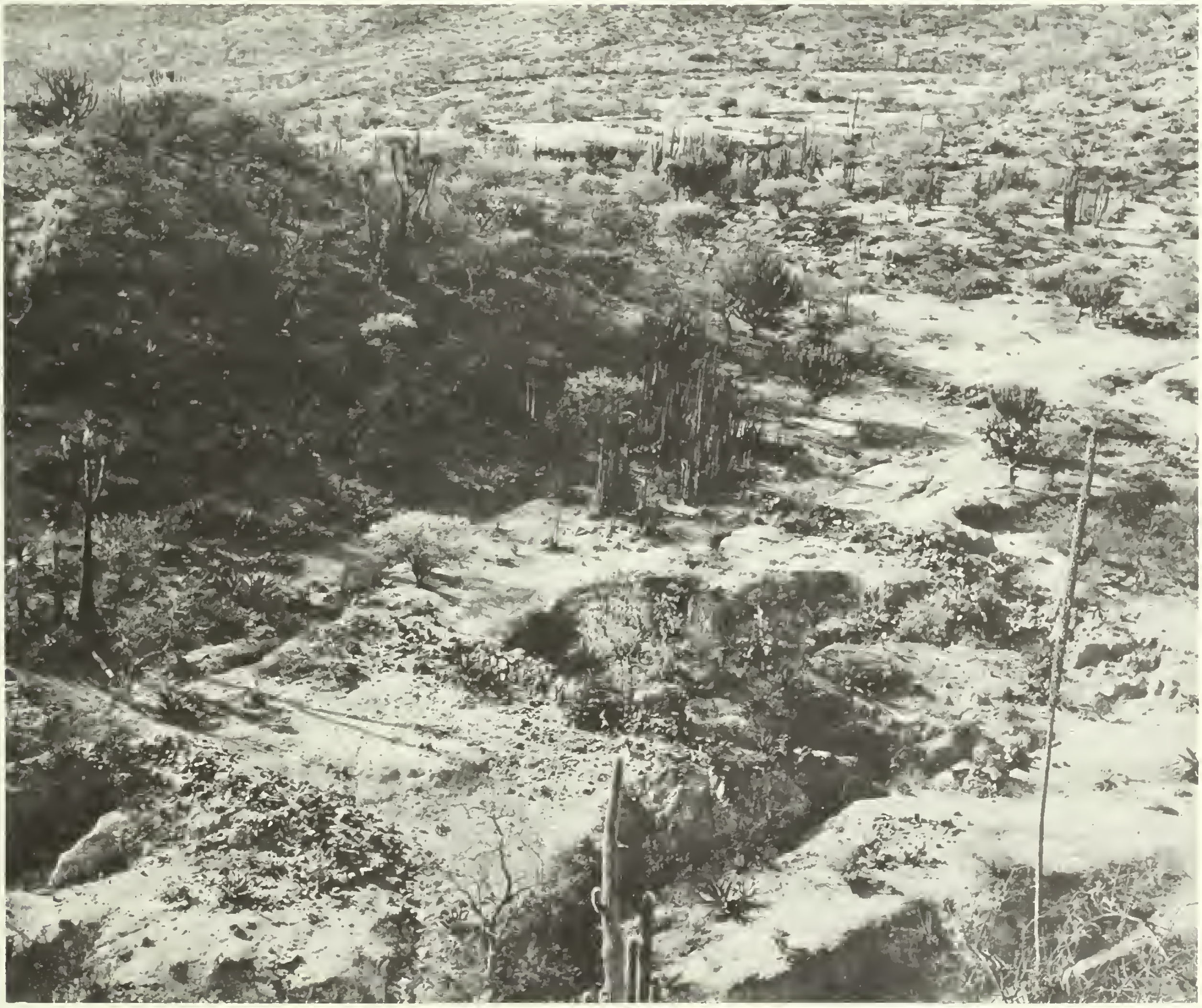


Fig. 50. Badly eroded farm terraces at Locality 4 of Fig. 47-B.

from these aerial photographs are illustrated in Fig. 47, A-D. The portion of no. 6610 on which Fig. 47-D is based is shown in Fig. 48 to indicate the extent to which the field patterns may be seen from the air. Preferably, of course, the patterns seen on the photographs should have been examined on the ground, but our limited time precluded walking the area with the completeness we would have wished. Although details of terrace construction could not be determined from the air, the relation of the field systems to the surrounding topography was far clearer than when the systems were examined only on foot. The relationship of the air views to ground observations is made apparent in Fig. 49, which shows several of the boulder lines of Tr 423, which can be seen in the upper left corner of Fig. 47-B. The lines of stone dividing the field are only faintly discernible on the ground, and then mainly because in this instance the field has apparently been re-used recently and the vegetation growing along the field borders has been left uncut. Area 4 of Fig. 47-B is shown in Fig. 50, looking south from a nearby hill. The effects of current erosion appear clearly, but even where badly disturbed, the terrace walls are identifiable when seen from above and over a large enough area. Most of these systems observed on the aerial photographs lay alongside the more conspicuous intermittent drainages, and across small channels that were either not discernible from the air or were so diffused by the system of walls or boulder lines across them that they were virtually obliterated.

Although the valley field systems identified from aerial photographs and sketched in Fig. 47 cannot be analyzed as to structural details of the terraces or boulder lines, it is possible to make rough estimates of their dimensions and thus of their areas. This supplements the valley field systems examined on the ground, providing a total of 42 fields for which calculations can be made. They range in area from 0.2 to 14.0 hectares. The whole group of measurements can be summarized most clearly as follows:

less than 1.0 hectare, 9 fields
1.0 to 1.9 hectares, 10 fields
2.0 to 2.9 hectares, 7 fields
3.0 to 3.9 hectares, 3 fields
4.0 to 4.9 hectares, 5 fields
5.0 to 5.9 hectares, none
6.0 to 6.9 hectares, 3 fields
7.0 to 7.9 hectares, 2 fields
8.0 to 8.9 hectares, 2 fields
9.0 to 13.9 hectares, none
14.0 to 14.9 hectares, 1 field

The average size of the fields is 3.0 hectares (about 7.5 acres), although admittedly the definition of boundaries from both observation on the ground and examination of aerial photographs is arbitrary, and estimates of distance are approximate.

Clues to the chronological position of agricultural systems are always scanty and frequently inconclusive. One may suspect that a field system is contemporary with an occupation site nearby, but proof of such a relationship is usually impossible to find. Farming localities are used for many centuries and improvements, such as terracing, may be made at an early date and continue in use for hundreds of years and even to the present. The fact that some of the field systems we describe here are in current use is no indication that they may not have originated many centuries ago. The surest guide to the period of use seems to us to be the presence of sherds in definite concentrations on various parts of a site, suggesting that users of the farm land occupied perishable structures seasonally, or at least "camped" in the fields; better is pottery associated with isolated single-room ruins, located adjacent to or within field areas. But even in these circumstances the association of sherds and fields is an assumption that cannot be elevated to certainty. On the basis of such ceramic evidence as we were able to secure from farming sites and the accompanying occupation sites, we can make the following tentative statements.

The chronological position of only twenty-one of the valley field systems could be estimated on the basis of sherds collected from the field areas and believed to be associated with their periods of use. Since some of the sites yielded few sherds, our placement of the fields is simply a rough approximation. Only four valley field systems (Tr 172, 317, 342, and 346) are assigned to the late Palo Blanco subphase, and in the absence of evidence to the contrary we have no reason to postulate that such farms were in use before this time. Seven sites (Tr 111, 197, 341, 343, 414, 418, and 424) can be placed in the early Venta Salada subphase and ten (Tr 313a, 313b, 313c, 314n, 314s, 326, 327, 330, 340, and 423) in the late Venta Salada subphase.

Although this is not a systematically drawn sample, and relative intensity of use in each subphase is thus not clearly indicated, we can at least conclude that once this farming technique was developed, it continued in use until the time of the Conquest as it has, in fact, continued to the present. Although, as has been pointed out earlier, valley and hillside systems are only variations on a single principle of water control, it may be significant that the technique was developed first for hillside use and later extended to the valleys or small intermittent drainages below and between the hill flanks. Although greater amounts of water might be collected in some of the valley locations, the flanks may well have been more desirable for farming from the standpoint of freedom from flood damage and simplicity of terrace construction.

Summary

If our distinction between valley systems and hillside systems as two variations of a single basic technique of soil and water control is valid, the latter variation appears to have come into use during the Palo Blanco phase, the earliest of the ceramically dated hillside terraces being in Tecorral Canyon. Their numbers increased with the passage of the centuries, and the technique was extended to valley floors late in Palo Blanco times, perhaps about the eighth century of the Christian era. The increase in the use of lines or walls of boulders to border and support fields may have come from a growing appreciation of the effectiveness of such systems and also from the demand for more and more land for cultivation, as the villages and seasonal camps of the Tehuacan Valley evolved to a growing number of secular centers deserving the term town or city. An estimate of population to be published in volume 5 of this series suggests a four-fold increase from Palo Blanco to Venta Salada times. Concurrently with the increase in population, there was a growth in commerce and in the concentration of political power, both trends requiring an expanding agricultural base.

We have noted that the valley systems averaged only 3.0 hectares in area, in comparison to an average of 7.3 hectares for the field systems on hillsides. This can perhaps be understood best as a reflection of the relative scarcity of arable land with adequate and manageable water supplies in the small valleys of intermittent streams. It seems probable to us that irrigated farming along the permanent streams and from the major springs of the Tehuacan region must have continued through the Palo Blanco and Venta Salada phases as the predominant source of agricultural production. At best, the small stone-bordered field systems here described would have been a minor adjunct, but in the face of increasing demand, an important one.

An impression of the extent to which the additional hectares of farm plots in small valleys and on hill flanks could have contributed to the subsistence base of the Tehuacan Valley may be derived from the useful calculations made by Charles Gibson (1964: 309-311). An acceptable figure for the "normal" yield of maize cultivation (without intensive irrigation) at the time of the Spanish Conquest in the Valley of Mexico is 17 bushels per acre, which is a little over 11 *fanegas* and is the equivalent of 2,338 pounds, or about 600 liters, of shelled maize per hectare. Gibson suggests that an average family would have required from 10 to 20 *fanegas* of maize per year; therefore the production from one to two hectares of land would suffice. This does not take into consideration the possible greater productivity of irrigated land along the permanent streams or the major intermittent streams on the east side of the valley, such as the Arroyo Lencho Diego, which drain the highest elevations in the vicinity, where the heaviest rainfall occurs.

Another means of judging the contribution that these prehistoric field systems might have made to the total productivity of the Tehuacan region is provided by the observations of Palerm (1955) based on field work at Eloxochitlan, a Totonac town in the highlands of Puebla. Each household depends on both a small garden *(calmil)* near the house and its *milpa* outside the town, the latter cultivated by the *barbecho* or "fallowing" system. The *milpa* yields one crop a year, and on the average a family needs two hectares of *milpa* and one-half hectare of *calmil*. Any particular plot of land must lie fallow for substantial periods with the result that for a complete cycle of cultivation and fallowing a family requires 6.5 hectares of farm land. Palerm points out that this is about half what is required in a lowland area studied, where swidden farming was practiced, but is seven or eight times the area required to support a family when land can be completely irrigated.

Although the total area over which field borders and terraces were constructed is considerable — and we have described here only a fraction of what might be found by more protracted and systematic search — it would be wrong to imagine that there is evidence for a sophisticated, widespread system of water management. Each field system is not only a small, self-contained unit, but it is probably the work of a single farmer or family group. With the stones for borders and walls lying close at hand, with construction either of dry-laid masonry or bound with simply prepared adobe mortar, and with no need for the construction of an entire system of fields to be complete before any part of it can be farmed, it seems probable that the labor of building these systems was intermittent and sometimes even incidental to other farming activities. It would be superfluous, perhaps, to labor this point if it were not for the recurring statements in print that

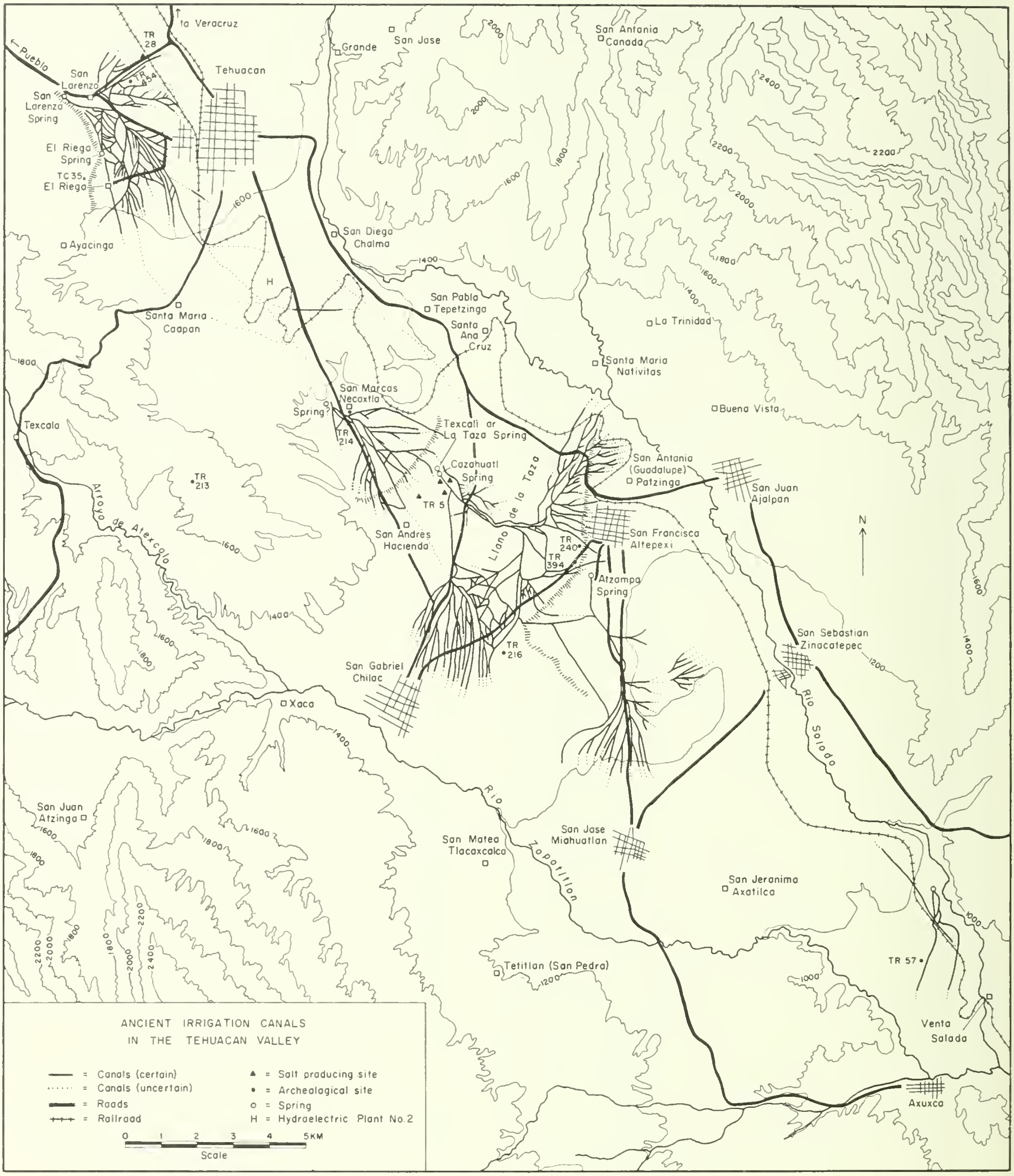


Fig. 51. Ancient canal systems of the Tehuacan Valley.

prehistoric farmers must have labored mightily to construct farming systems that may actually have been built over many centuries and chiefly in spare moments. For example, C.E. Smith, Jr., in summarizing his impressions of prehistoric farming in the Tehuacan Valley (1965*a*:73) states, "the time required to do all this handwork is beyond the imagination." On the contrary, consideration of the details of field systems and evaluation of the actual work involved provides a basis for viewing these field patterns as the expectable results of moderate efforts and not as fantastic achievements of the days of the giants. We could not find convincing evidence of permanent irrigation channels leading water into any of these terraced field systems, except at Tr 447, but wherever they were built across the main drainage of a small valley the terraces were designed to spread the water horizontally, at right angles to its natural flow. This would have been feasible with simple, temporary ditches constructed at the time that the fields were being prepared for planting; such ditches would leave no permanent trace.

The Fossil Canal Systems

Although it is generally assumed in discussions of the importance of pre-Columbian irrigation in Mesoamerica that archaeological evidence can and will be found of its origins and early extent (see, for example, Palerm 1955), such evidence is by no means conspicuous or conclusive in most areas. It is far more often the case that fields, canals, diversion points, and other parts of prehistoric water systems are extremely difficult to identify, much less to assign accurately to a chronological position. Therefore, we felt that the numerous and conspicuous "fossil" canals of the Tehuacan Valley offered great promise for providing a more detailed picture of past irrigation systems. Without the need for excavation, the mineralized canals could be examined, identified, and mapped by field reconnaissance in the brief time we had available. Fig. 51 indicates the location of all major fragments of "fossil" canals and suggests the locations of connecting portions for which the evidence is inconclusive.

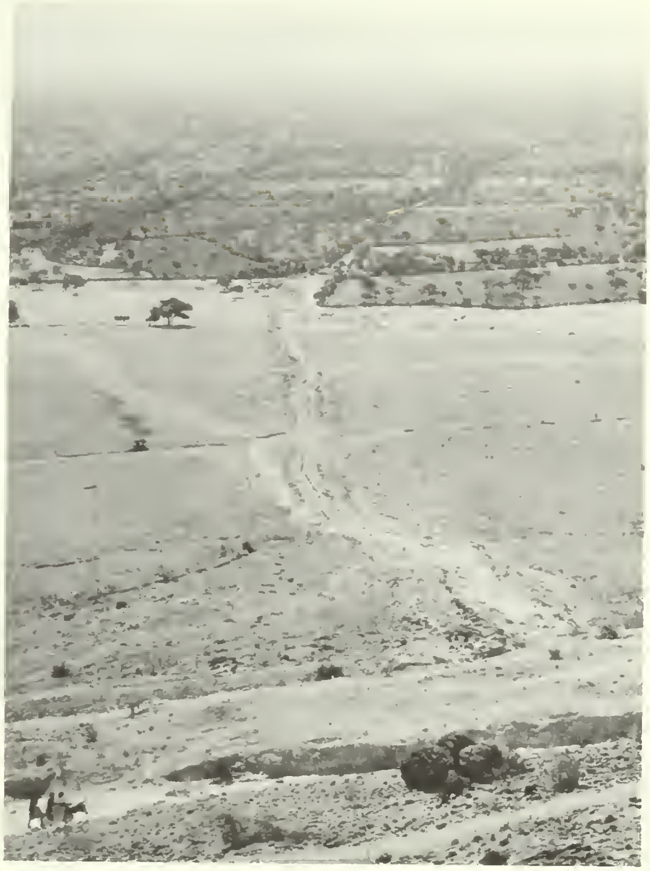


Fig. 52. Fossil canal descending Altepexi Scarp near Tr 240; the road to Chilac cuts the canal in foreground.

The remains which we facetiously began to refer to as "fossil" canals have been naturally preserved by the deposit of calcium carbonate on the interior surfaces of their channels, thus effectively preserving in "fossil" form the original conformation of the channel. Some of these fossil canals lie essentially at the surface and others stand above it as a result of erosion of the surrounding soil. The thickness of the calcium carbonate deposits suggests that in many cases deposition was quite rapid or continued for long periods or both. Locally these *apantle* — or irrigation ditches, from the Nahuatl *apanatl*, meaning "water channel" (Peñafiel 1885: 56-57) — are called *tecoatle* by the Nahuatl-speaking inhabitants of the valley today, a term meaning "stone snakes."

Processes of Deposition

Although the geology and hydrology of the Tehuacan Valley have already been summarized by Byers and Brunet in volume 1 of this series (Brunet 1967; Byers 1967), a review of a few details as they apply to the formation of fossil canals is appropriate here.

A large part of the rainfall on the higher borders of the Tehuacan Valley on the northeast, north, and northwest percolates rapidly into the earth and slowly moves through the predominantly calcareous formations of the valley's flanks. Eventually this ground water reaches the surface as springs, particularly at the points where surface erosion has intersected the main aquifers. Although Blasquez (1957: 32-33) re-

TABLE 13

Evaporation and Precipitation in the Tehuacan Valley *(in mm.)*

	Average evaporation at El Riego (1938-55)	Average precipitation at Tehuacan (1939-45, 1947-55)	Excess of Evaporation
January	135	0	135
February	150	0	150
March	200	0	200
April	195	15	180
May	190	60	130
June	165	90	75
July	160	50	110
August	170	70	100
September	140	100	40
October	150	20	130
November	135	10	125
December	130	0	130
Total	1920	415	1505

SOURCE: Approximations based on Comisión del Papaloapan 1956*a*, Láminas 11 and 12.

marks that the evident alignment of the San Lorenzo, El Riego, Texcali, Cosahuatl, and Atzompa springs may indicate a major fault or a fracture caused by tectonic action, Brunet's study of the geology of the valley does not support this (1967: 77).

It is relevant to the distribution of fossil canals that no major springs occur south of the settlement called Venta Salada and that only one occurs south of the scarp passing through San Francisco Altepexi and above the Atzompa spring. We have not been able to determine from the geological data available whether the concentration of springs in the north section of the valley is due to structural or to topographic factors, and from the standpoint of the prehistoric water users it is unimportant. But since the fossil canals appear to depend largely on major springs, their distribution is determined ultimately by the physical characteristics of the valley and its water resources.

While passing through the calcareous formations that underlie the valley, the ground water takes on a heavy change of minerals, particularly calcium bicarbonate. A daily reminder, while we lived in Tehuacan, of the nature of the spring water could be seen on the label of the bottled "Peñafiel Water" regularly available not only locally but throughout Mexico. An analysis said to have been made by the Instituto de Geologia de la Universidad Nacional de Mexico indicated the following mineral content (in mg. per liter): SiO_2, 43.2; $NaNO_3$, 3.04; $CaHPO_4$, 0.056; LiCl, 0.008; KCl, 13.70; NaCl, 82.31; Na_2SO_4, 76.85; $NaHCO_3$, 29.54; $Mg(HCO_3)_2$, 167.27; and $Ca(HCO_3)_2$, 455.80.

The high calcium content results from the fact that the carbon dioxide present in the water facilitates the formation of calcium bicarbonate from the abundant calcium carbonate in the rocks through which the water moves to the springs. This process can be briefly summarized thus: $CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2$.

The "fossilized" canals are thus the result of calcium deposits — generally termed "travertine" — on the interior surfaces of the artificial water channels. The appearance of such travertine deposits may vary greatly according to their mineral components and the manner in which they were deposited. Some of the travertine in both the modern and fossilized canals was evidently deposited quite rapidly, as indicated by the light, crumbly, vesicular nature of the deposit. However, the majority of the material is heavy, hard, and very compact, probably resulting from a slow rate of deposition. The fresh deposits of travertine forming in the presently functioning canals are predominantly white and beige in color. Varying degrees of oxidation of the iron present in travertine are manifested by the shades of yellow, brown, and red found in both homogeneous and banded forms. The light to dark gray color as well as the rough, pitted surfaces characterizing the fossil canals are evidently a result of weathering. Freshly broken surfaces are quite similar in color and texture to recently deposited travertine.

Observation of present-day canals discloses a heavy growth of plants on the sides and bottom of some; relatively little in others. Since mineral deposits form

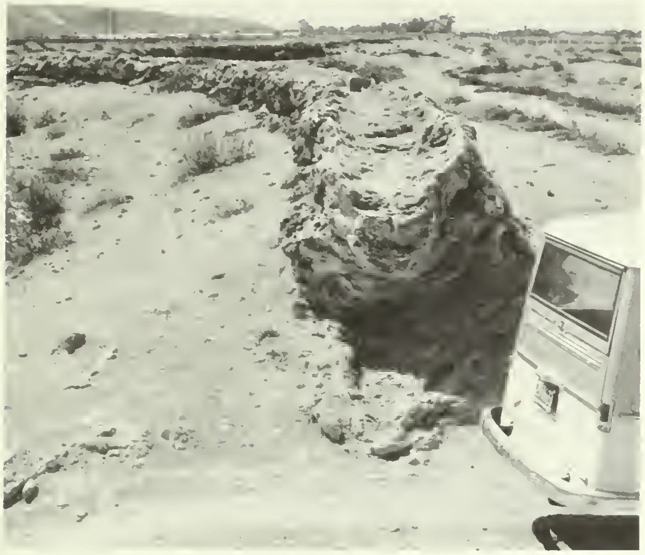


Fig. 53. Fossil canal near El Riego, cut by road and standing nearly 2 m. above present land surface.

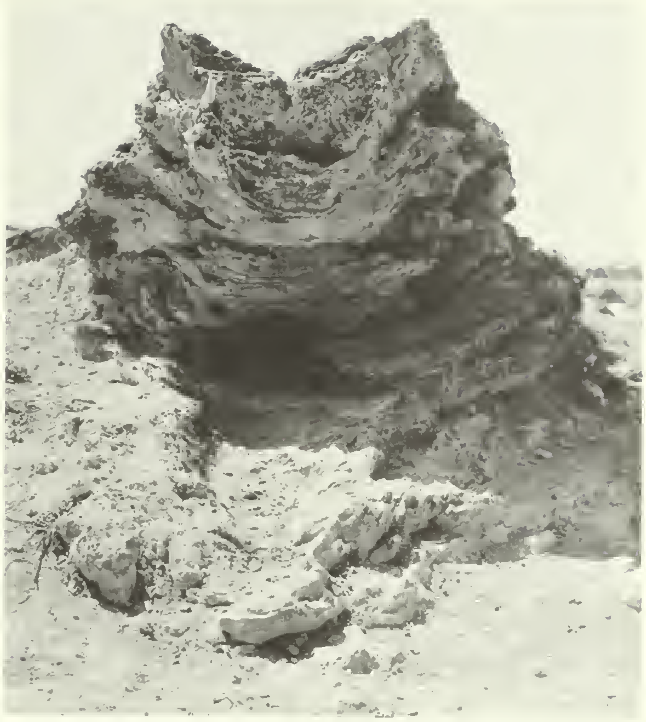


Fig. 54. Detail of canal shown in Fig. 53.

rapidly in some of the canals on every grass blade, twig, and leaf, the porous, vesicular deposits of travertine in prehistoric canals may reflect similar conditions in the past. Examination of broken exposures occasionally revealed casts of twigs or impressions suggestive of grass. Some of these channels would have been highly favorable for plant growth, as suggested by the fact that "the conditions conducive to aquatic growth are a clear, warm, shallow water flowing at a low velocity" (Zimmerman 1966: 272).

The deposit of the travertine is due to a complex interaction of chemical, physical, and biological processes, although one standard text on irrigation disposes of the matter as follows: "Where the water and soil are high in calcium carbonate, the canals gradually stabilize (against erosion) by forming a protective coating (incrustation) and even creating quite stable drops" (Zimmerman 1966: 276). A reduction in the amount of carbon dioxide in the water would increase precipitation of calcium carbonates. The reduction could come in part from the presence of algae, grasses, and other forms of vegetation in the canals, and in part from the agitation of the water, its rise in temperature as it flowed in open channels after leaving the springs, or a decrease in hydrostatic pressure (Twenhofel 1950: 373-374). Evaporation was probably a major cause of deposit of minerals, and carbonates are among the first deposits from heavily charged water (*op. cit.*, p. 376). Evaporation greatly exceeds actual precipitation throughout the Tehuacan Valley, with the disparity greatest in the months of March and April. Table 13 compares evaporation and precipitation, using data from the El Riego and Tehuacan meteorological records, stations only about 3 km. apart with the longest records appropriate to the area here dealt with.

As shown in Figs. 53 and 54, the travertine deposits are conspicuously stratified. This was probably caused by changes in the rate of deposition as a result of fluctuations in the factors just mentioned and by periodic disuse or reduced flow. Although there is no basis for assuming any climatic changes since these canals were in operation, minor changes from decade to decade in rainfall and temperature would influence the flow of springs. More importantly, the increased evaporation rate during the dry season (February to June) would reduce the flow in such shallow channels.

The Natural or Artificial Origin of the Channels

A question we faced at the beginning of our examination of these systems of fossilized channels was whether they might be entirely of natural origin or were the result of human efforts. A natural origin was suggested by the fact that they drained away the water pouring from the major springs of the valley, the channels appearing to flow along paths of maximum grade across the sloping valley floor. Also sug-

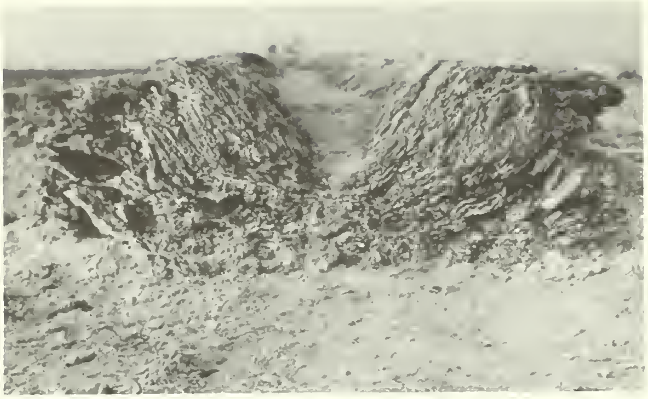


Fig. 55. Cross section of one of the smaller canals (Tr 394B), showing its U-shaped profile.

gestive was the fan-like arrangement of the channels, a pattern familiar where swift mountain streams spread out over alluvial fans at the edge of a valley. However, some of the channels did not follow natural gradients, and the total pattern appeared to distribute the spring water rather effectively to the available farm land. In addition, we found a few places where the side of the channel was notched, apparently to permit water to flow out in small amounts to adjacent fields (see Fig. 57). Finally, the similarity of fossil channels, now dry, to modern irrigation canals in the Tehuacan Valley supported the conclusion that the old channels were artificial. This conclusion was corroborated by Jean Brunet of the Tehuacan Project and by Maurice E. Cooley and E.W. Davidson of the United States Geological Survey office at the University of Arizona. In their opinion, although portions of the systems in the immediate vicinity of the springs may be of natural origin, the major portions of the channels were made by man.

It is possible that what we now see in the Tehuacan Valley is a highly developed system of canals for water distribution that has been adapted and developed from natural channels that originally extended out from each spring. It is impossible, of course, to prove the possibility that at first small parts of the flow were used by farmers with fields close to the springs, adapting the natural drainage channels to the purposes of irrigation. As they developed familiarity with the problems of directing water at appropriate grades to selected locations they could have expanded the canal system. Mistakes in the excavation of such channels would have been corrected, when not too extreme, by the flow of the water, since a watercourse will naturally modify the width, depth, and grade of its channel to bring such variables as erosion and deposition into an equilibrium with maximum functioning efficiency (Lobeck 1939: 155-183). In this hypothetical origin and growth of spring-fed irrigation in the Tehuacan Valley improvements would have come as farmers experimented, made mistakes, and learned more about how to control water for agricultural purposes. It is not unreasonable to regard the rather sophisticated canal irrigation used in the valley today as the end product of such a process, reflecting a long span of local development from simple beginnings.

Description of the Canals

The aptness of the Nahuatl name *tecoatl* (stone snake) for these fossilized channels is easily appreciated at first sight, for they twist across the relatively flat valley floor in a complex network. In some areas dozens of them stand to varying heights (about 15 cm. to 3.5 m.) close together and roughly parallel. Although their formation can be attributed to deposition, erosion has played a role in creating their present appearance. Both wind and water have eroded the soil adjacent to the canals, sometimes leaving them freestanding to their very bases on one or both sides (Figs. 53 and 54). In a few locations the canals have slumped and broken because of severe undercutting resulting from erosion.

The canals that appear to be main channels range from about 1.5 to 3.0 m. wide, whereas the small canals, evidently used to distribute the water from the main canals to the fields, range from about 0.3 to 1.0 m. wide. As is characteristic of the functioning canals in the valley today, the stratified cross sections of the fossil canals were approximately "U"-shaped (Fig. 55). The freestanding remnants gave us no clues concerning their initial depths, and we did not excavate any of the partially buried canals, as this would probably not have given us a true indication because of the effects of erosion. Since, however, nearly all of the present-day active canals range in depth from approximately 0.3 to 1.0 m., the majority of the fossilized canals must have fallen within this range. This supposition is based on the close similarity of other characteristics (i.e., width, cross-section, distribution, and so on) shared by both groups of canals.

As Fig. 51 shows, there appear to be three major systems of fossilized canals in the Tehuacan Valley, the first beginning just west of Tehuacan and at one time extending into the area now occupied by the western edge of the town; the second and largest beginning near San Marcos Necoxtla and extending southeast to an area between San Sebastian Zinacatepec and San José Miahuatlan; and the third, of which least remains, located north of Venta Salada. A rapid, but thorough, reconnaissance of the area leads us to believe that the first two canal systems mentioned may have been a huge single system, some 25 km. in length, as is the functioning system today. However, because of the lack of evidence indicating exactly the routes followed by the postulated connecting canals, we can only indicate by dotted lines the most direct probable courses of such canals, as dictated by the topography of the area. Our reasons for suspecting the two systems as having been joined at one time are threefold:

1. The discovery of an isolated remnant of a fossil canal in the triangular area between Santa Maria Coapan, San Diego Chalma, and San Marcos Necoxtla leads us to believe that the linking canals once present were destroyed because of agricultural pursuits in that area. Smith (1965*a*: 61-62) states that "the level areas of the Tehuacan Valley are among the most intensively cultivated localities in Mexico." In the areas apparently intensively cultivated from colonial times into the present, such as those south and southeast of Tehuacan, around Coapan, Chalma, and San Pablo Tepetzingo and around Necoxtla and the Hacienda San Andres; those north, east, and south of Altepexi; those west, south, and east of San Gabriel Chilac; and those around Miahuatlan (Paredes Colin 1960: 169-175; Chap. 4, this volume), there is little evidence of fossil canals. A few remnants are to be found, but the majority have been broken up and piled along the edges of the fields or used for road ballast. In and around Chilac we noticed that such travertine was also utilized in the construction of some of the walls dividing the fields and surrounding homesteads and the foundations of a few houses. We observed several instances of fossil canals completely disappearing at the point where they reach groups of fields now under cultivation, apparently having been destroyed to permit freer access and more extensive cultivation. Furthermore, the present canals bringing water for the irrigation of such fields often parallel the routes followed by the fossil canals, at least upon entering the cultivated lands. Others, however, do not correspond at all as they enter the fields from a different direction and have a different source. With these facts under consideration it would seem that the basic nature of the fields, the field patterning, has changed since the use of the fossil canals and may, therefore, have been a contributing factor in the destruction of these canals. This changing of field patterns could, of course, have taken place under the influence of the Spanish in the Colonial Period or in more recent times. The change from hoe to plow cultivation, for example, would have made larger fields much more efficient to cultivate. Unfortunately, we have no data at hand bearing on prehistoric patterning of fields or changes in such patterning for the Tehuacan region since the Conquest.

2. The modern canals issuing from the San Lorenzo spring are joined with those of the Llano de la Taza. As we have found the modern canals nearly always to parallel remains of fossil canals, it would not be unreasonable to find the two canal systems under consideration linked in prehistoric times as well.

3. One final argument for the joining of these systems is the possible realization on the part of the ancient agriculturalists of the desirability of a complete system, that is, the need to end the systems of canals in some sort of drainage channels and thus dispose of the overflow of water not utilized. The modern canals, and apparently the fossilized canals too, although their route is not so well defined, empty into natural drainages. The systems ending near Chilac and Miahuatlan drain into the Rio Zapotitlan while those ending between Altepexi and Santa Maria Nativitas and between Altepexi and Miahuatlan drain into the Rio Salado. The canal system north of Venta Salada drains into the Rio Zapotitlan today, although it may well have had some drainage into the Rio Salado in the past. In any case, as there is really no large natural drainage between the central and northern canal systems this would suggest that they may have been joined in the past, just as today the canals beginning at the San Lorenzo Spring connect with the canals near Chilac and near Miahuatlan. Although we failed to discover the details while in the field, it is also probable that this same modern system continues to the vicinity of Venta Salada, thus forming a single system some 35 km. long.

A clue against such a linkage was noted, however, during the interview of a resident of Necoxtla. This old man recalled the presence of a spring "just north" of Necoxtla which he believed to have been functioning until a "few years ago." Unfortunately, however, the old man could not, or was reluctant to, give us exact information as to where the spring was located. The presence of such a spring near Necoxtla is further verified by Paredes Colin (1960: 177) who notes that the springs which supply water for the irrigation of the lands belonging to the Hacienda San Andres "have their origin in the terrain belonging to Necoxtla." We were unable to discover the spring by surveying the area ourselves, and we could not find anyone else with any knowledge of it. Therefore we do not know whether the fossil canal system beginning just north of Necoxtla actually originated there or if the spring merely augmented the water supply flowing southeastward

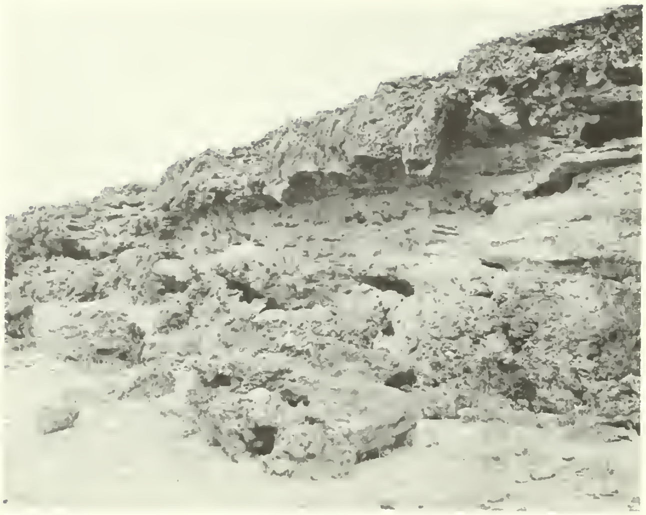


Fig. 56. Travertine deposited on rim of canal, apparently by overflow; total height about 2 m. (canal Tr 394A).

from the San Lorenzo spring toward the Llano de la Taza.

We should emphasize that all of the fossil canal systems (or the single unified system) appear to have springs as their sources, and never originate in either permanent streams such as the Rio Salado or in the many intermittent streams coming into the valley from the surrounding hills. No fossil canals were found on the east side of the valley, where larger amounts of water come down from the mountains, and where there are no major springs. Although no accurate figures are available as to the present flow from the springs used to supply the fossil canals, it is not only substantial but is subject to much less fluctuation seasonally than is the flow from surface streams. Tributaries of the Salado coming from the west are, in fact, notably scarce in the area watered by the fossil canals.

The Functioning of the System

The grade of this canal system can be calculated within the limits of accuracy of our maps, and assuming that our locations for the individual canals and their connections are approximately correct. The elevations that follow have been estimated as closely as possible from the topographic maps prepared by the Papaloapan Commission. From the San Lorenzo spring (el. 1680 m.) to the apparent termination of the canal system just north of Miahuatlan (el. 1170) there is a drop of 510 m. in about 28 km. of canal. This is a grade of about 1:55 or 1.8 percent. The grade is a little steeper in the upper part of the system, a reflection of the steepness of the valley floor in the area between Coapan and Chalma, where today the railroad makes a series of switchbacks south of Tehuacan. The southern 17 km. of the canal system, from the Necoxtla spring (el. 1400) to the area just north of Miahuatlan has a grade of about 1:74, or 1.35 percent, noticeably less than for the system as a whole. If the canals we have shown on our map continued all the way to the Venta Salada system (which is possible but not demonstrable), the grade would have been quite similar, approximately 1:65 or 1.5 percent for this hypothetical extension of 13 km.

Grades are by no means uniform, of course, as they follow closely the natural slope of the valley, with neither deeply cut nor markedly elevated sections. Where the channels drop off the scarps at Altepexi and San Andres, they plunge steeply for several hundred meters. The same steep slope carries irrigation water successfully today, erosion being kept to a minimum by the heavy travertine lining of the canal. One of these modern canals is shown by C. Earle Smith in his essay on agriculture of the Tehuacan Valley (Smith 1965*a*: fig. 22).

Since we lack measurements of the rate and volume of flow of the modern Tehuacan canals and their prehistoric counterparts, we cannot judge them by the standards of modern irrigation engineering, even if we were competent in this highly specialized field. Nevertheless, the maximum grade we calculated (1.8 percent) is suitably within the normal limits referred to in modern discussions of irrigation practice. For example, a general discussion of irrigation in arid lands states, "Irrigation by gravity-flow through water channels and over the ground surface is difficult to maintain on slopes exceeding 2° (3.5 percent), and very difficult on slopes exceeding 4° (7.0 percent). Still steeper slopes must be excluded even though the difficulties could be surmounted by making terraces . . ." (Greene 1966: 258). In similar vein, Zimmerman (1966: 276) refers to "networks" with "a canal running down a steep slope of say 2 to 4%" resulting in serious erosional problems where the grade changes abruptly. Current advice provided by the United States Soil Conservation Service to farmers in the western United States, however, suggests much flatter grades than these: "You should lay out your ditches on relatively flat grades, having a fall of not more than one or two inches per hundred feet [0.8 or 1.7 percent]. Ditches with a fall of more than three inches per hundred feet [2.5 percent] are apt to erode because of the higher flow velocities" (Soil Conservation Service, Washington, D.C., 1959, p. 20).

The modern Tehuacan Valley canals follow approximately the same grades as the prehistoric ones, often paralleling the fossil canals for their entire length, and they appear to function with adequate efficiency. Because of these grades the water flows rapidly in most canals, reaching the fields quickly and thereby reducing loss by evaporation and seepage. However, this rapid flow is also wasteful, for there is ample evidence of water being lost over the sides of the canals. In the past this overflow evidently was constant and heavy enough to precipitate thick deposits of travertine over the sides of the canals (Fig. 56). We suspect, however, that the beneficial role played by the grade of the canals in increasing the longevity of the systems far outweighed the disadvantages. In addition to being largely instrumental in the precipitation of calcium carbonate, the rapid flow also served to transport suspended material over the entire system and thus reduce the deposition for any particular spot. Although this rapid flow appears to have resulted in some loss by overflow, this very action would have built up the walls of the canals so that they maintained a channel and continued functioning despite deposition on the floor of the watercourse.

Observation of the canal system in use in the valley today suggests the manner in which the system functioned in the past. The permanent canals can be blocked with small barriers of stones, brush, and mud to divert water into temporary distributory channels leading through the fields. Fig. 57 illustrates small sluices cut in the side of the travertine wall of a canal, a detail of construction usually obscured by the damaged condition of the surviving canals. This technique would have permitted small amounts of water to be directed into the adjacent fields at many points for whatever length of time was needed (or permitted) for a particular plot. At the present time, water is temporarily diverted from earth ditches into adjacent fields (see Fig. 58).

No traces were found in the vicinity of the fossil canals of retaining walls or terraces used to level the fields that these canals watered. However, these canals, for the most part supply relatively level areas so that only minimal modification of the field borders would have been needed. Also, recent erosion has more greatly altered these parts of the Tehuacan Valley than any others, possibly owing to severe overgrazing. It is reasonable to surmise that where the slope of the land necessitated it, low earth banks or terraces were constructed in the past much as they are today, to hold sufficient water on each parcel of land to ensure thorough soaking and to prevent irrigation water running off with resultant erosion. Modern fields under irrigation are shown in Figs. 58, 59, and 60 (see also Smith 1965*a*: fig. 17).

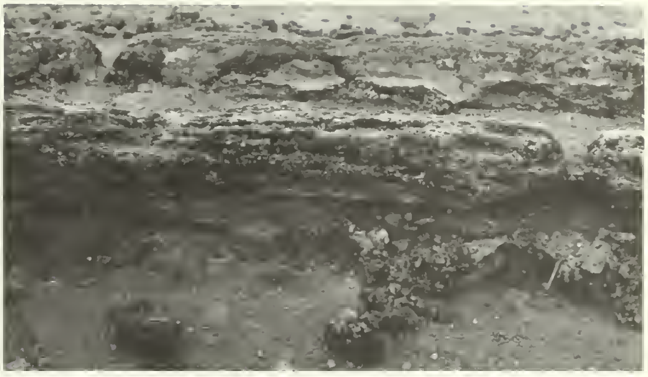


Fig. 57. Small fossilized ditch with notched sides, believed to be for water diversion.

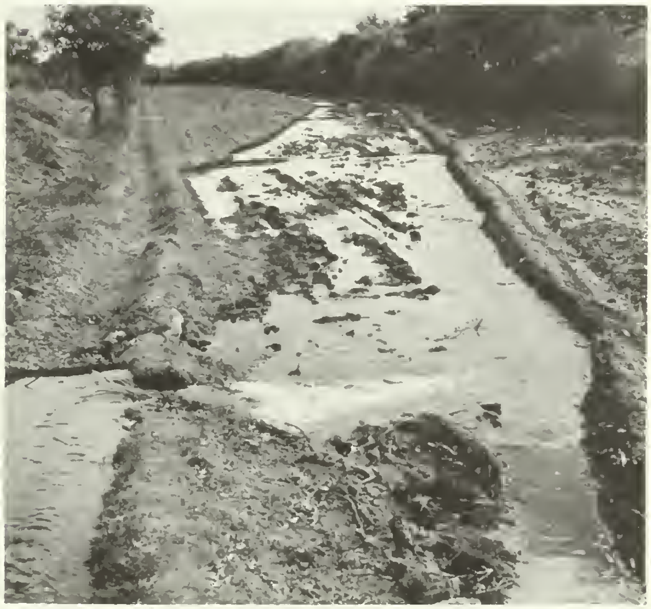


Fig. 58. A field near El Riego being irrigated with water temporarily diverted from a small earth ditch.

As in existing fields (Fig. 58), the water was probably distributed throughout the cultivated plots simply by flooding. This process, however, suggests another of the many problems present — how did the farmers cope with the calcium carbonate and other salts deposited in the fields from the waters they used for irrigation? Our survey indicates that such deposits are currently accumulating in the fields now under cultivation. The foreign materials deposited in the fields appear as a thin whitish crust, called *tepetate*, or

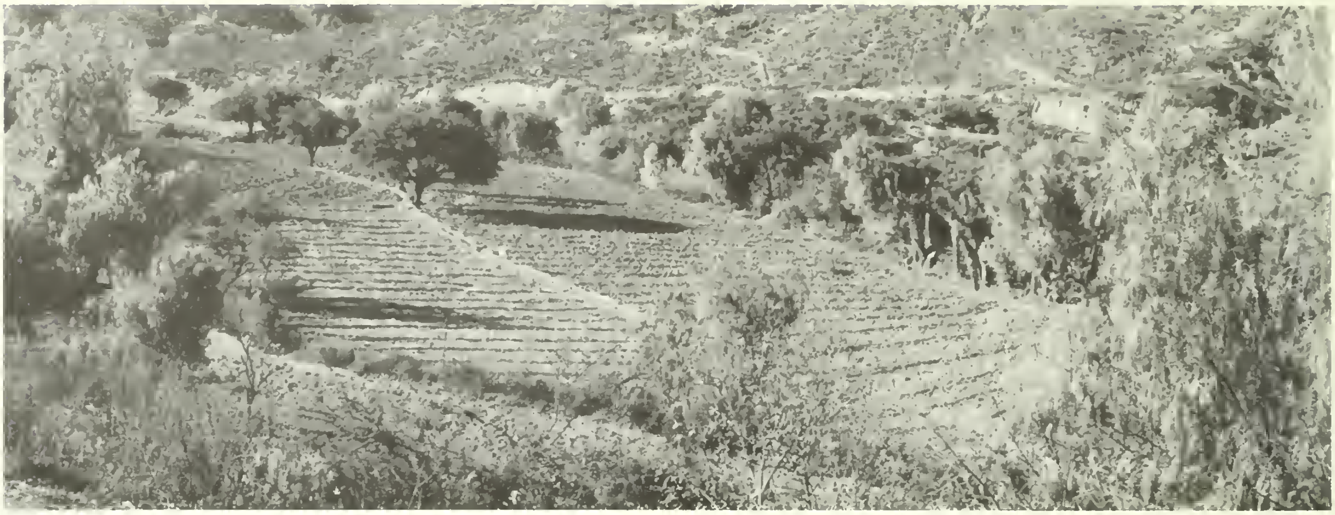


Fig. 59. Modern irrigated fields south of Texcala with furrows to carry water from the ditches running down the slope.

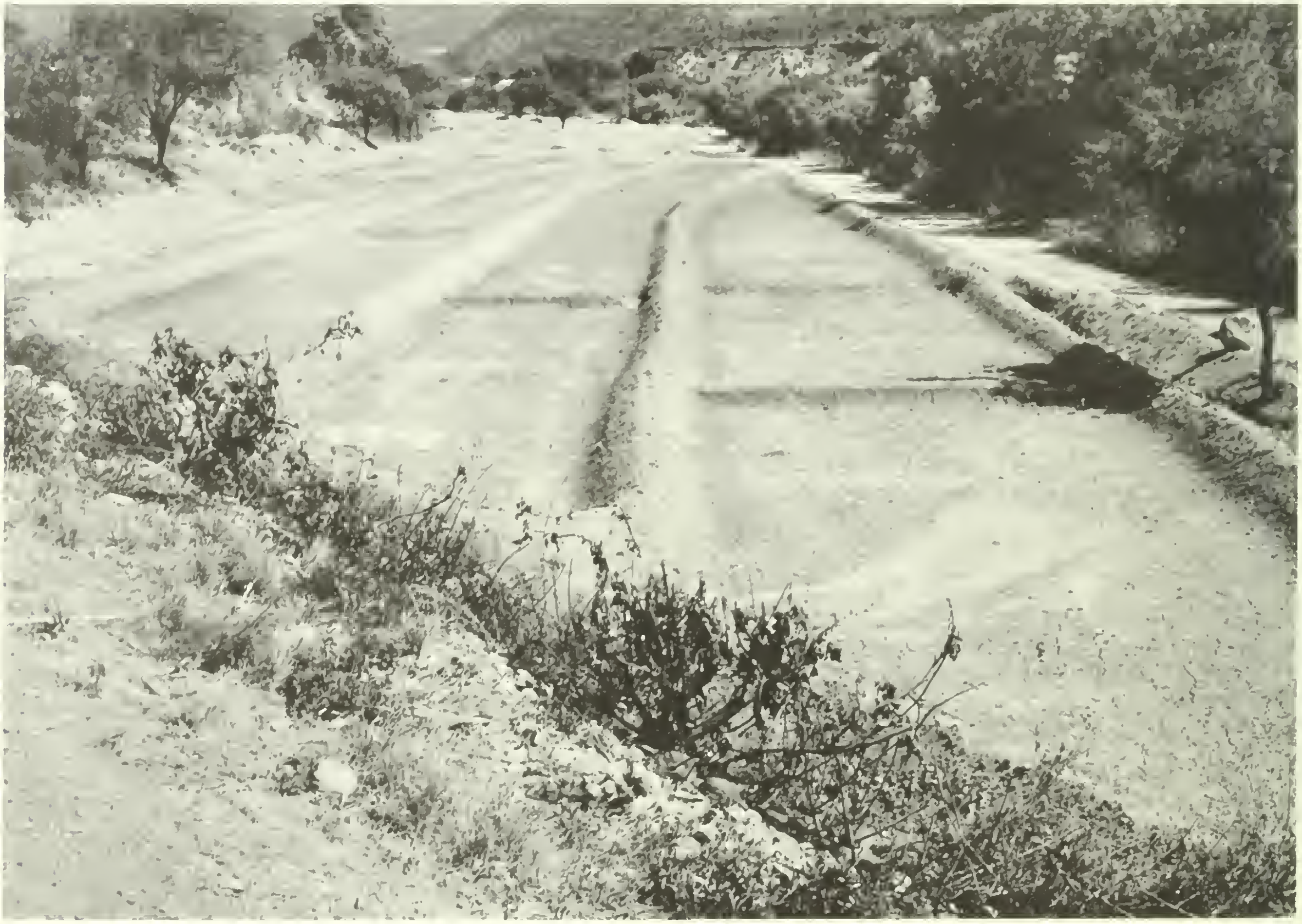


Fig. 60. Modern irrigated field at the southeast edge of Tehuacan, with border ridges on contour benches.

more often as a whitish powdery cement in the surface soil. Although this deposition is a severe problem, present-day farmers seem to have a technique for alleviating the situation. By flooding the fields with more water than is actually necessary for the crops, they flush the accumulated calcium carbonate and other salts deep into the earth, a process greatly facilitated by the porous nature of the soil. Slowly, however, the fields do become impregnated with excessive salts and have to be abandoned. Our informants stated that the only recourse upon this eventuality was to allow the fields to lie fallow for several years until they could be used again. It is quite possible that, as the calcium carbonates can be taken back into solution with relative ease, by allowing the fields to lie fallow for several years the light rains received by the valley would slowly flush away the deposited *tepetate* and cleanse the fields. From Colonial times to the present this process has been accelerated by plowing the fields to permit more rapid and thorough flushing to take place and by applying natural fertilizers to replenish and enrich the soils.

Smith, writing about the vegetation of the Tehuacan Valley (1965*a*: 58), describes the saline soils as follows:

> The second of the specialized vegetational areas are the soil patches in which a geological formation bearing saline springs has produced marked saline plains. Irrigation over a very long period of time with the highly mineralized waters from the larger natural springs, which rise in the northern end of Tehuacan Valley, has also resulted in saline areas. The first kind of saline area is clearly seen around Petlanco . . . The second kind of saline soil condition is found near the Cerro San Andrés just outside San Gabriel Chilac where heavily mineralized waters from the upper reaches of the valley have apparently been used to flood the fields for centuries. A part of this area is so saline that little vegetation grows on it.

The Age of the Canals

Tracing the relatively conspicuous and easily defined fossil canals of the Tehuacan Valley would serve little purpose if their approximate antiquity could not be determined. Unfortunately, clear clues to their age are scarce. The most immediate possibility, judging the age of a canal from the rate of deposit of its travertine, turned out to be futile — deposition rates are controlled by numerous factors, most of them beyond our means to determine, such as the original mineral content of the water, its temperature and rate of flow at a particular point, and its evaporation rate. Less direct lines of evidence, however, as detailed in the following paragraphs, indicate beyond doubt that these canals are prehistoric and suggest that their construction and use was chiefly from the late Palo Blanco through the Venta Salada phase and into historic times.

It should be mentioned in passing that the possibility of radiocarbon dating of the travertine was considered, since such dating has been attempted in at least one other locality, Tule Springs, Nevada (see Haynes, Doberenz, and Allen 1966: 517). However, it appeared improbable that a radiocarbon determination could refine or even strongly support the dating arrived at by other means, since it would reflect to an uncertain extent the antiquity of the spring water flowing in the canal, thus giving only a date subsequent to which the deposit must have formed (Austin Long, pers. commun.).

The age of the fossil canals was first suggested, during surveys of the Tehuacan Valley, by their proximity to salt-production and habitation sites. Channels were found near the bases of hilltop sites, such as Tr 216, and close to sites on the valley floor, such as Tr 57, 214, 240, and 454. Such fossil channels are well situated to have supplied domestic water to these settlements, while at the same time taking water to the fields for irrigation. This combined function is illustrated today in the village of Necoxtla. It is possible, of course, that the canals were dug and used long after these habitation sites were abandoned, and pass near them by chance, but the association is at least suggestive.

Two salt-production sites, Tr 5 and Tr 28, were noted in close proximity to fossil canals. Several other salt sites lacked traces of canals, but in view of the frequent breaking up of such canals to facilitate plowing or to provide building materials, canals could formerly have existed. The water brought to the salt-producing sites was probably used to wash salts out of impregnated earths (see Gibson 1964: 338), the water then being evaporated, leaving a mass of salt that could be shaped into a block for transport, sale, and consumption. Gibson comments that the modern process of solar evaporation was probably not used in prehistoric times.

Both the habitation and the salt-making sites are dated by pottery as belonging to the late Palo Blanco and Venta Salada phases.

A more direct means of dating than these associations between canals and sites was provided by the finding of sherds in the canals themselves. While tracing some of the canals on foot to note details not observable on the aerial photographs, we found a total of nine sherds imbedded at varying levels in exposed walls of fossil canals. Unfortunately, the pottery types represented are not all datable to short time spans, and the number of sherds is quite small. Nevertheless,

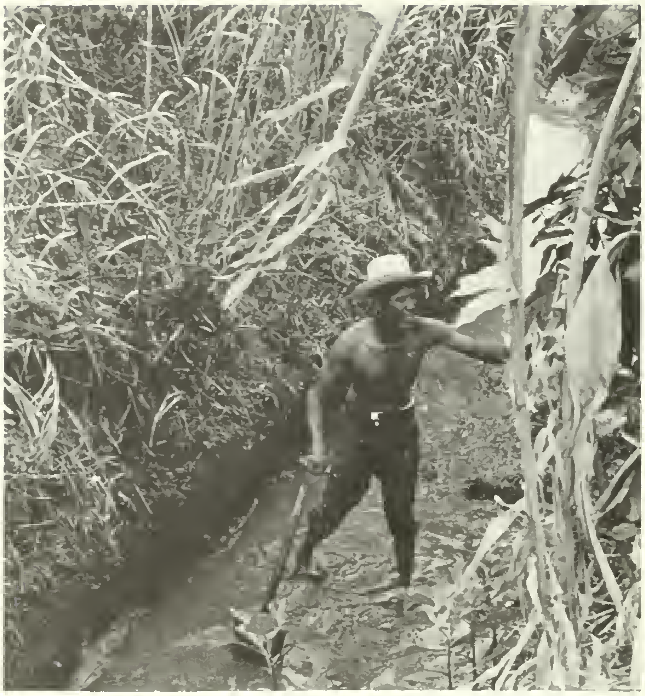


Fig. 61. Cleaning a modern irrigation ditch.

the presence of Coxcatlan Brushed, Coxcatlan Red, Coxcatlan Gray, and Teotitlan Incised sherds (identified by R.S. MacNeish), all ceramic types characteristic of the Venta Salada phase, offers satisfactory agreement with the previous evidence. It is possible, of course, that a few sherds from the large quantities of prehistoric material strewn about the fields fortuitously lodged in canals functioning during colonial or modern times, but in the small sample obtained no colonial or modern sherds occurred, nor did those of earlier phases, which are also represented in the areas through which the canals passed.

Recently, a small-scale parallel of the Tehuacan fossil canals has been examined at Hierve el Agua, near Mitla, Oaxaca. This system is fed by springs with a high mineral content and has therefore been preserved by deposition similar to that of the Tehuacan canals. Its most noteworthy feature, determined by careful and extensive test digging, is that it came into use about 500 to 300 B.C. (Neely 1967; Flannery *et al.* 1967). Because of its small size and earlier date, however, the canals and fields covering some 50 hectares only, it may be more comparable to the Tehuacan Valley's Formative irrigation systems than to the fossil canals of the Venta Salada phase, extending over an area at least 25 km. long and 10 km. wide.

A respectable antiquity for the Tehuacan fossil canals is also suggested by the fact that they were permitted to accumulate to such thicknesses and that they were then abandoned only to be closely paralleled by additional canals, themselves later abandoned in turn. Interviews with landowners, some of whose families have possessed lands within the Tehuacan Valley since the eighteenth century, and with farmers and members of irrigation cooperatives produced claims that some of the presently functioning canals have been in use three hundred years or possibly longer. Such longevity for modern canals is supported by Gil's history of San Gabriel Chilacatla (Chap. 4), which indicates that portions of two of that town's canals were first excavated sometime between 1530 and 1539. These are the canals now leading from the springs known as Texcalli and Cozahuatl. The former means a rocky elevation, escarpment, cavern, or lair of wild beasts (Simeon 1885: 448) and can be translated broadly as "cave," rather than "house of stones," as stated by Gil. Cozahuatl is more easily translated as "place of yellow water," from *coca,* yellow; *huia,* particle for place; and *atl,* water (Fernando Horcasitas, pers. commun.).

Modern canals are not built up high above their original position, in spite of continual deposits of travertine, because they are now and probably always have been cleaned regularly of their mineral deposits. This cleaning now takes place from one to three times a year, depending on the amount of accumulation; informants were vague, however, on specific reasons for the cleaning, except for stating that the canals would eventually "not function properly" if left uncleaned. We were told that such cleanings were not imperative to the successful functioning of the canals, as they will maintain their gradient and a sufficiently deep channel to remain effective for many years without cleaning. However, if not cleaned at least once or twice a year, it takes two or three times the effort later to clean the travertine accumulation, as it becomes harder with the passage of time. The cleaning is done with spades and steel bars, since even when fresh the deposits are quite dense and hard (Fig. 61).

We suspect, from our observations, that canals may have been cleaned little or not at all in prehistoric times, since to do the work with wooden or stone tools would have involved far more effort than is needed with metal tools. We did not observe any disturbance in the stratified travertine deposits where they have been conveniently cut through for modern roads and canals (see Figs. 54, 55). Although this is negative evidence, it is reported for what it is worth. We must assume, then, that in pre-Conquest times a canal would gradually accumulate deposits which both raised the level and narrowed the channel, until a time came when water was lost at low points of slower deposition or the flow was seriously reduced. Then a new canal would be dug paralleling the old one, and irrigation could proceed effectively for another period of years. This procedure would explain the large number of essentially parallel channels that can now be observed, and for which there would seem to have been no need if they had been in use simultaneously.

The duplication of canals has probably ceased or greatly declined since the introduction of iron tools in the sixteenth century. If cleaned regularly, any particular canal could continue in use almost indefinitely. In fact, there are a few examples of what appear to be ancient fossilized canals which have been slightly modified in modern times, either by cleaning out the old channel (Fig. 62) or raising the sides with stone and cement (Fig. 63). These, however, may merely be modern canals that went too long uncleaned and could then be kept in use more easily by a combination of partial cleaning and building higher sides.

It is also suggestive of a difference in canal maintenance practices between prehistoric and colonial times that fossil canals are conspicuously absent in field areas probably cultivated since colonial times, particularly around the Hacienda San Andrés and around Altepexi. It seems improbable that just in these areas ancient canals would have been so thoroughly cleaned that they would resemble recent ones.

In the course of his geological studies of the Tehuacan Valley, Jean Brunet also became interested in archaeological problems, including the fossil canals. In volume 1 of this series he has presented a series of comments and speculations on the subject (1967: 73-82). His attention is particularly directed to whether the date when these canals were built and used could be ascertained by geological means. Brunet's reasoning proceeds from the initial belief that in the relatively recent geological past the Rio Santo Domingo has "captured" by headward erosion a formerly closed Tehuacan-Cuicatlan basin, thus draining its lake and initiating severe erosion, which in turn has caused a marked and progressive lowering of the water table. The extent and the rate of this drop in the water table is deduced by Brunet from the following: (1) El Riego rock shelter, 22.5 m. above the present water table, acquired travertine deposits from a "veritable waterfall" about 7,000 years ago and was still "very damp up to some 4,000 years ago"; (2) at the time of the Conquest or a little later "various old texts" refer to "trenches" built for irrigation that are assumed to be ditches about 1.0 m. deep; (3) an old well digger recalls that at the beginning of this century underground "water galleries" were at a depth of "a few meters," which is assumed to mean the abandoned galleries that lie at a depth of 3.0 to 5.0 m.; (4) in 1964 a modern chain well system known as El Huizache was dug in the vicinity of El Riego with its underground channels at a depth of 10 m., which is taken to reflect the position of the water table today. When these data are converted to a curve (Brunet 1967: 82, fig. 46), it shows that "the successively higher levels at which water was obtained represent levels of increasingly greater age. This makes it possi-

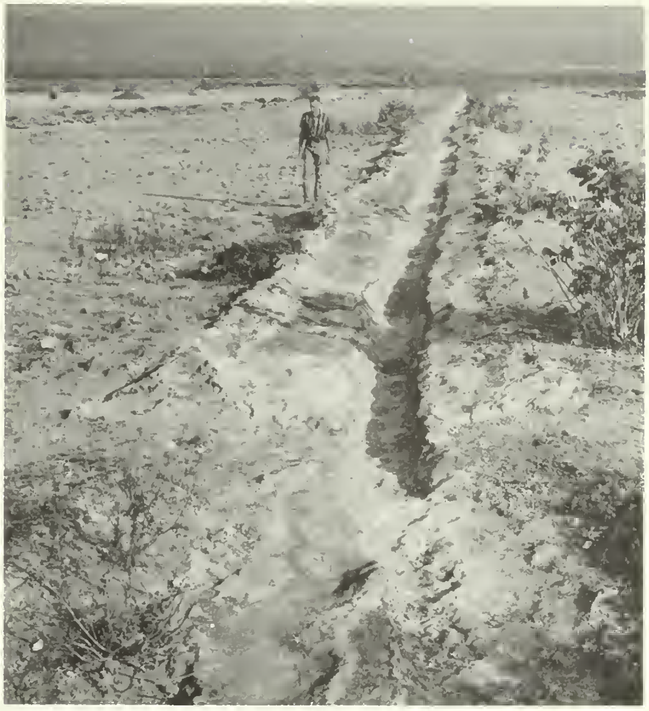


Fig. 62. An old ditch with a new and smaller channel recently cut into the travertine (Tr 394C).

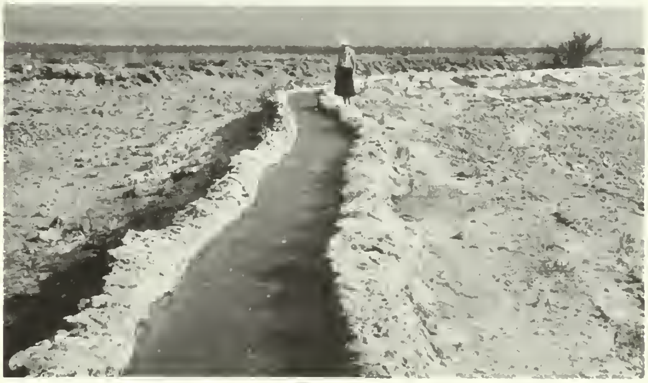


Fig. 63. Modern canal made by building up the sides of a fossil canal with masonry, near Chilac. Abandoned and partly destroyed fossil canals are visible in the background.

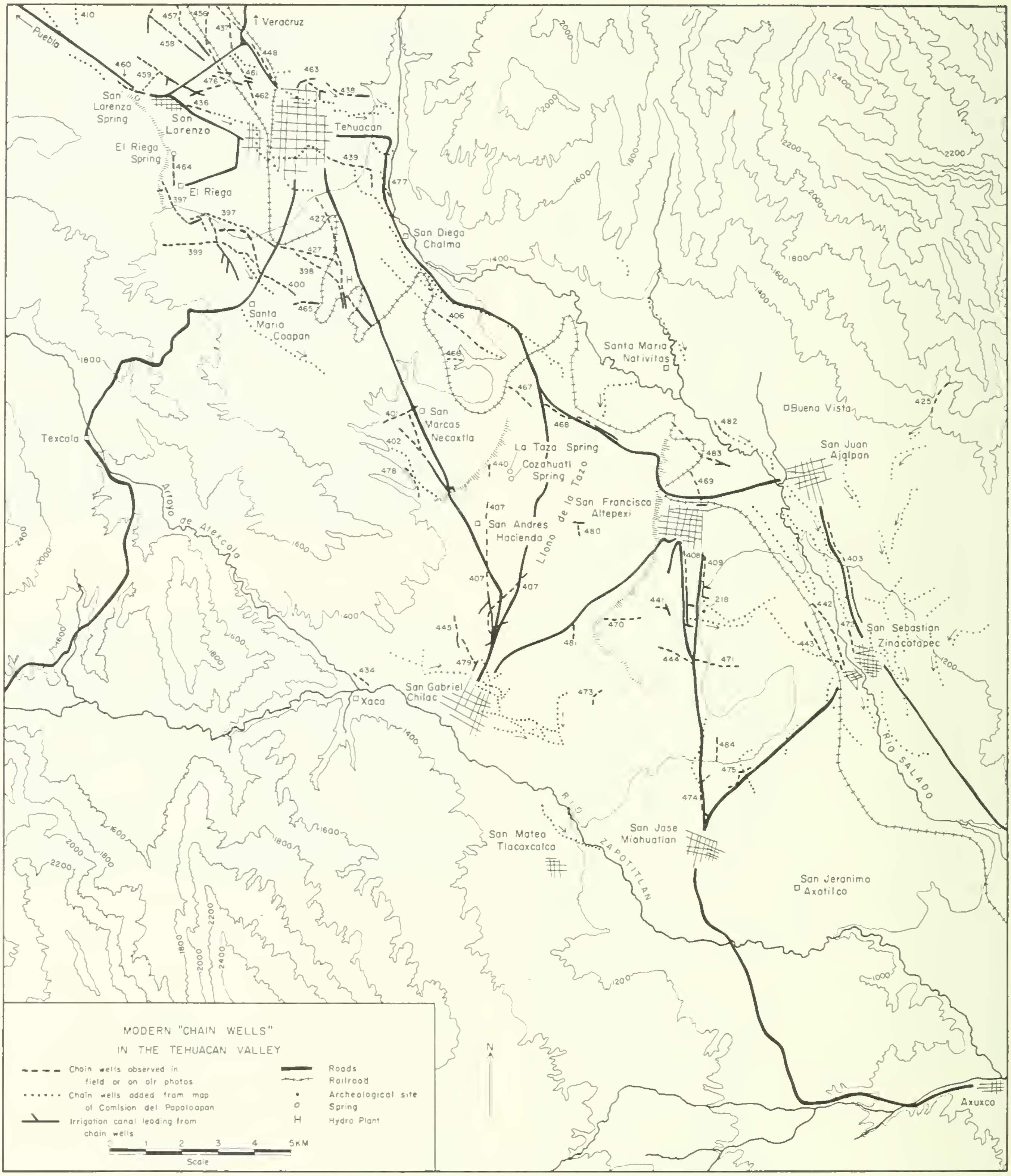


Fig. 64. Chain well systems of the Tehuacan Valley.

ble to date pre-Hispanic canals with wholly relative precision. Those radiating from El Riego were in use between A.D. 1000 and the Spanish Conquest and had maximum use about 1200." Other irrigation systems in the valley cross the El Riego area and run about 10 m. above the galleries that radiate directly from El Riego.

Brunet's conclusions suggest a somewhat later date for the El Riego canals than do the lines of evidence presented here. Possibly, in attempting to treat chain wells and spring-fed canals together, and in relying on the recollections of an elderly well digger for the depth of the water table at the turn of the century, he has introduced errors into his reconstruction. In addition, his scheme requires the assumption that the water table has dropped at a uniform rate, which cannot be proved, and he overlooks the fact that canals need not flow at the level of the spring that feeds them, but only at a level no higher.

Therefore, we are left with several lines of archaeological evidence, all in agreement, but each relatively weak, and the historic evidence collected in 1962 by Gil Huerta and presented in Chapter 4. The archaeological evidence points to the construction of the fossil canals from late Palo Blanco times onward, yet Gil's study includes no definite reference to systems of canals in the valley prior to the work begun by the Franciscans. His interpretation of the sources indicates that water from at least the Texcalli and Cozahuatl springs "flowed over the plains without benefit to anyone." Earlier irrigation channels are not mentioned, although the Franciscans described the location and excavation of the canals whose construction they directed. Gil's pioneering work suggests that further documentary and ethnohistoric studies would be well worth undertaking to help resolve this and other interesting historical questions.

Chain Well Systems

One other type of irrigation feature was briefly studied during our work in the Tehuacan Valley: an extensive network of subterranean tunnels linked with the surface by a series of vertical shafts or "wells." These systems are used to tap underground water sources and transport the water to desired locations. They are in many ways similar to the Near Eastern *qanats*, also known as *karezes* and *foggaras*.

We have referred to the Tehuacan systems as "chain wells" because of their distinctive form (Figs. 64-67) and to avoid using a specific term from the Near East. In the Tehuacan Valley they are known as *galerías*, *galerías filtrantes*, and *apantles con tragaluces* (galleries, filtration galleries, and channels with skylights).

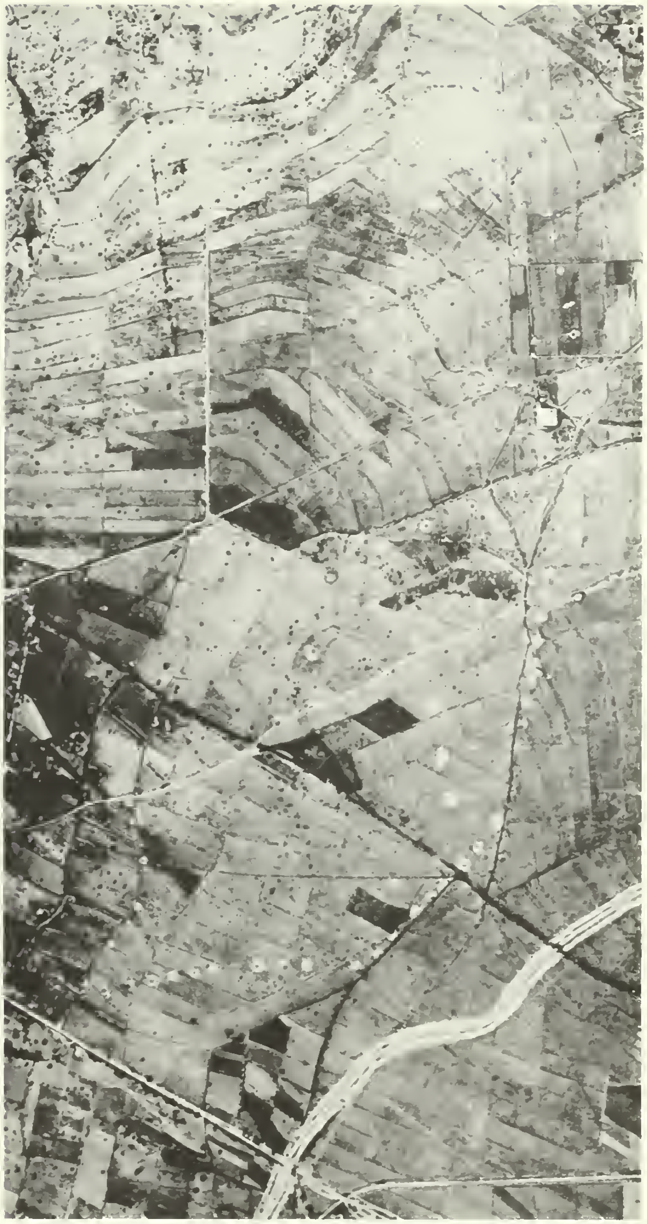


Fig. 65. Air view of chain well system 397, southeast of El Riego. Chain wells appear as white circles. (Photo by Comisión del Papaloapan, no. 3373.)

These systems have been briefly mentioned in several sources. The thesis of Manuel G. Hidalgo Fuentelsaz (1958) and publications by the Comisión del Papaloapan (1954), Luis Blasquez L. (1957), and Carl Troll (1963) are the most informative. We can supplement these works with information on the age of the systems and with observations on their construction, their extent within the valley, and how they function to augment other systems of irrigation within the valley today.

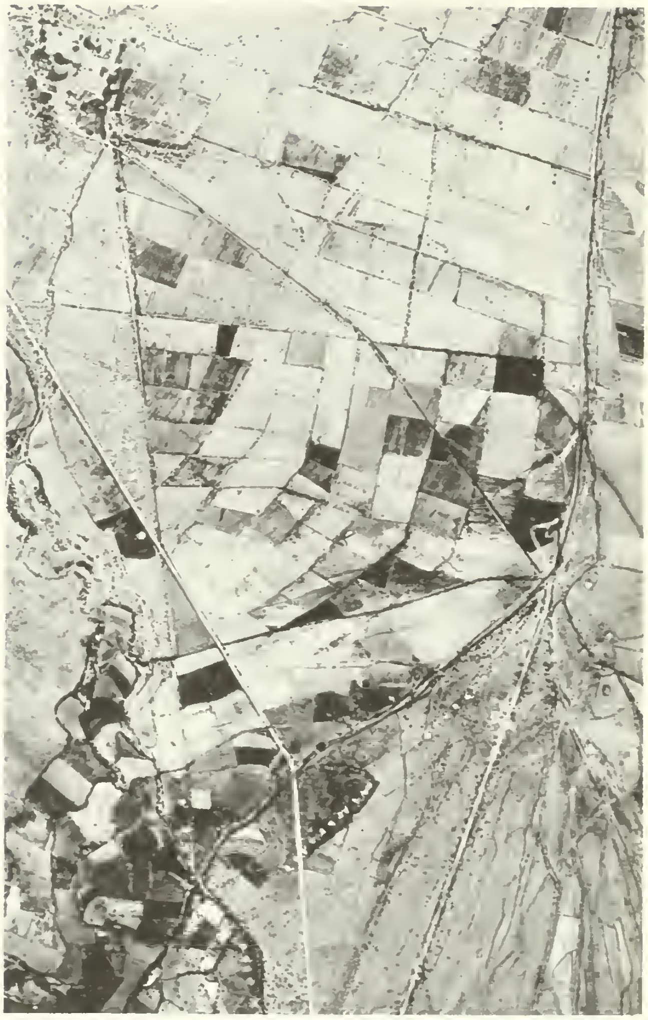


Fig. 66. Air view of chain well system 407 and fossil canals south and east of Hacienda San Andres, leading toward Chilac. (Photo by Comisión del Papaloapan, no. 3413.)

As with the other water-control and irrigation features discussed in this report, we have attempted to map the chain well systems with reasonable accuracy (Fig. 64). However, accuracy and detail were lost in some cases owing to two factors: (1) time limitations and the extent of the area surveyed did not permit us to investigate personally every feature, and those features discovered by means of the aerial photographs were in many cases not sufficiently distinct; (2) features discovered in the field were not always discernible on the aerial photographs from which we compiled our maps because of the high level at which the photographs were taken and the fact that many features had been changed or added subsequent to 1942 when they were taken.

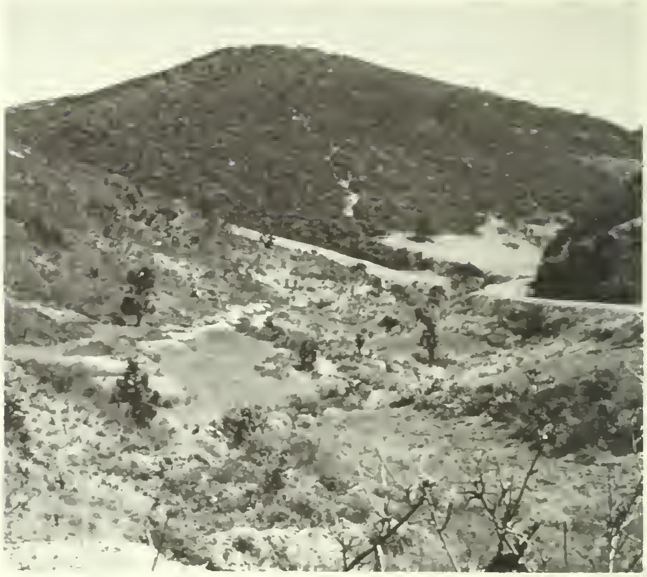


Fig. 67. Looking up the line of shafts of chain well system 395, alongside the Tehuacan-Veracruz highway. Shafts appear as white mounds from left to center.

Functions

The primary function of the chain well systems is to provide water for domestic purposes and irrigation. Because of the pressures of increasing agricultural irrigation and a constantly lowering underground water supply, which will be considered in more detail below, the inhabitants of the northern portion of the valley have used the chain well system to augment the water from the many natural springs in the area. A second important function of the chain well systems is to provide water for the beverages and medicinal baths for which the region is so well known (Armendaris 1902: 46-57; Blasquez L. 1957: 53-55) and which form the basis for Tehuacan's primary economic and industrial endeavors. Springs originally supplied these needs, but the increasing popularity of the mineral waters and the resulting increase in the number of spas and bottling plants made the use of chain wells a necessity. In more recent times, the increasing volume of business and the hydrological problems discussed below have caused the larger bottling plants nearly to abandon the chain well systems in favor of deep, machine-drilled wells.

Chain wells have also supplied water for hydroelectric plants in the northern portion of the valley. In this use several chain well systems are excavated in such a manner that they converge at the basin of the power plant. In the case of the now defunct Hydro-electric Plant No. 2, about three kilometers south-southeast of the city of Tehuacan, some of the chain wells apparently served the dual purpose of supplying water for the power plant as well as for agriculture. We could not determine if this were truly the case or if the chain wells were modified to irrigate the fields after the plant went out of use. Because of the relatively high cost and low yield of electricity from such sources and the tremendous drains on the subterranean water sources, most of the plants supplied by chain wells have been closed. Electricity is now primarily supplied from large hydroelectric plants outside the Tehuacan Valley. Such industrial use of the water provided by chain wells is not unique. Cressey (1958: 29) notes the application of qanat systems in the Near East to supply water to power grain mills.

Types of Systems

Our survey disclosed two basic types of chain well systems in the Tehuacan Valley. The first, and most prevalent, may be referred to as an "open system." It is one in which the nearly horizontal tunnel is extended as an open canal (Fig. 73). In other words, when the tunnel reaches a point where it approaches the surface of the earth within 2 to 4 meters, it is continued as an open canal which carries the water to the fields to be irrigated. This appears to be basically the same form represented by the majority of the Near Eastern qanat systems. We have referred to the second type as a "closed system." In this case, either because of the relatively small area in which the system is to be excavated (i.e., the limits of the landholding) or because the landowner cannot afford a more extensive system, the system both begins and ends with vertical wells. A windlass system and buckets are used to lift the water up through the shafts. Distribution is accomplished by pouring the water into the fields or into small canals which run from near the well openings to the fields.

The use of buckets and a windlass was also noted at shafts near the origin of a few of the "open systems." In the latter cases, the water was evidently drawn for domestic uses as well as for irrigation. A possible variety of this type may be represented by the well of the Hotel Iberia, located in the city of Tehuacan. However, as we could obtain only vague information on the subject, there is some question as to whether the well at the Hotel Iberia is the first or the last shaft in the system, or if it is part of a system at all. The qanat systems in the cities of Hamadan, Iran, and Madrid, Spain, which will be referred to below, represent Old World counterparts to this type of chain well system. In the Old World examples, access for the citizenry was attained by windlass and buckets through the vertical shafts or by expanding and modifying the shafts so that one could descend to the tunnel by means of flights of stairs.

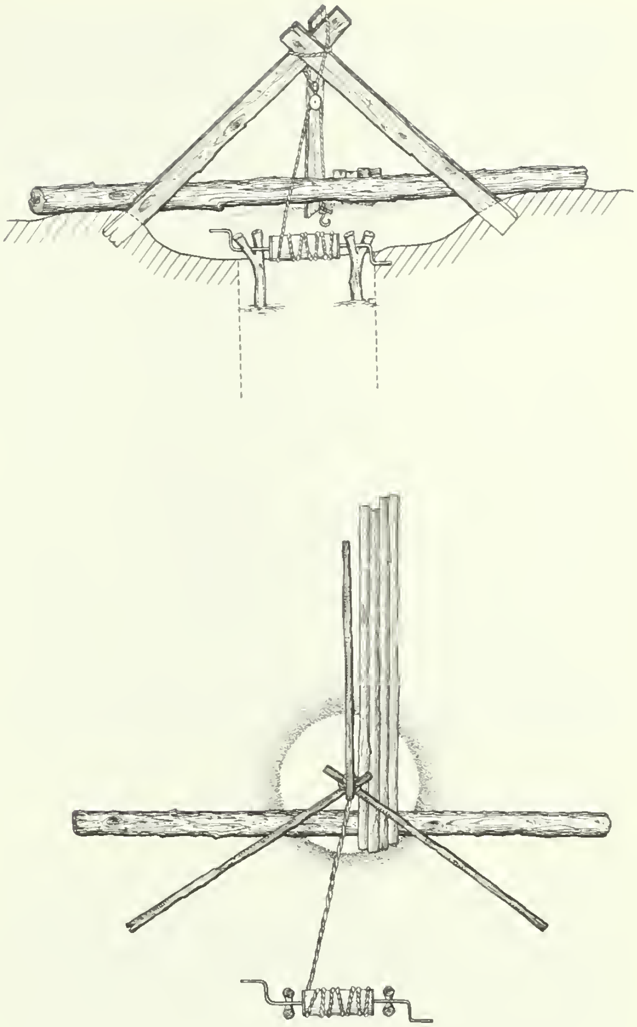


Fig. 68. Sketch of temporary platform and windlass used in excavating or cleaning a chain well. Apparatus used in cleaning a shaft of chain well system 397, in March 1964, consisting of three 2 x 8-inch boards supporting a pulley, an access platform of four 2 x 6-inch boards resting on an 8-inch diameter log from a freshly cut tree, and a drum of wood turned with handles of a ⅝-inch diameter iron, resting in forked supports from a freshly cut tree. A rope from the drum over the pulley ends in a hook on which is hung a bucket for removal of earth and rock from the well and tunnel. (Drawing by E. G. Schumacher, based on a field sketch by J. A. Neely.)

Physiographic Aspects

The chain well systems have been most frequently excavated into the moderately sloping floor of the northern portion of the valley, although several begin in the foothills and just inside the mouths of canyons (for example, Ts 425 and Ts 478).

These systems function through the penetration of the water table of one or more of the deeper aquifers that characterize the northern portion of the Tehuacan Valley (Brunet 1967: 81-82; Comisión del Papaloapan 1954: 27; Blasquez L. 1957: 47-48; Hidalgo Fuentelsaz 1958: 40-41). As Brunet has explained the geological and hydrological situation to us, there appears to be a difference between the Tehuacan chain wells and the Near Eastern qanats. This difference consists in the fact that in addition to acting as filtration devices to tap the water table, as the majority of the Near Eastern qanats seem to function, the Tehuacan systems often also act as the means to penetrate relatively shallow aquifers located between or separated by more impervious geological strata. The well-stratified travertine Quaternary deposits of the Cerro de la Mesa formation (Brunet 1967: 70-73, 82) allow rapid percolation of surface water and the formation of aquifers, yet are soft enough to permit the excavation of the chain wells. In the southern portion of the valley, generally south of a line drawn through the towns of Chilac, Miahuatlan, and Zinacatepec, the porous deposits end and harder, less pervious limestones, sandstones, breccias, and so forth, characterize the geological structure. Correspondingly, the character of the drainage also changes, and south of this line surface water becomes much more prevalent. It is probably primarily because of the presence of surface water and the denseness of the stone, which would greatly increase the difficulty of excavation with hand tools, that the chain well system in the Teotitlan del Camino area (Comisión del Papaloapan 1954: 50), in the extreme southern end of the valley, is the only one that has been excavated south of the Chilac-Miahuatlan-Zinacatepec line. One final factor may have discouraged chain-well excavation in this area. As there is considerable gypsum in the deposits in the southern portion of the valley, water obtained by means of chain wells would probably be charged with gypsum, making the water unpalatable and harmful to the soils and plants.

Although the chain well systems proved to be an answer to the increased needs of the valley's inhabitants and the problem of a naturally lowering subterranean water source, they were only a temporary solution. In addition to the increased demands for water briefly related above, the very use of the chain wells has probably accelerated the lowering of the water table. The excavation of deeper systems to tap new aquifers may well have served to increase the rate of depletion of the water supply in more shallow aquifers as well as to rob other chain well systems. According to Don Pedro Montes, who has specialized in the excavation of chain wells for approximately sixty years, there has been a drop of from 10 to 12 m. in the subterranean water sources (water table and aquifers) in the area of San Diego Chalma — a few kilometers southeast of the city of Tehuacan. The seriousness of the situation is attested to by the studies of Blasquez L. (1957: 53-54) and Hidalgo Fuentelsaz (1958: 30-37) which indicate that the exploitation of the subterranean water sources by means of springs and chain wells has reached a limit beyond which more water would be removed than could be replaced through natural processes. This situation was apparently realized somewhat earlier, for the present law prohibiting the excavation of additional chain wells in the Tehuacan region is mentioned in the report published by the Comisión del Papaloapan (1954: 18).

The importance of the chain well systems as additional water sources overshadows the relatively low flow which they yield. Blasquez L. (1957: 43) lists the flow of nineteen of the chain well systems located in the vicinity of the city of Tehuacan as ranging from 8.5 to 304.5 liters per second. The average flow of these systems would be about 47 liters per second. Hidalgo Fuentelsaz (1958: 32-36) presents slightly higher figures, stating that the maximum flow found among the 103 functioning chain well systems studied was 564 liters per second while the average was about 58.5 liters per second. Data from Blasquez's report indicate the average flow of the springs in the area to be about 1.6 times greater than that of the chain wells. Hidalgo Fuentelsaz's data indicate the average flow of the springs to be about 3.4 times greater than that of the chain wells. The flow of the Tehuacan chain wells seems to fall well within the range of the equally varied rates of flow of many of the Near Eastern qanat systems (Wulff 1968: 99), but is surpassed by the flow of the larger qanats (Cressey 1958: 28).

The Tehuacan Systems

As may be noted in Wulff's diagram (1968: 94-95), the head or proximal end of the nearly horizontal tunnel of a chain well penetrates the water table of one or more of the deeper aquifers. The tunnel extends from these water-bearing strata in the direction of the slope of the ground surface. The slope of the Tehuacan Valley is from the northwest toward the southeast, so most of the chain well systems generally follow this orientation. As the slope of the tunnel is usually much less than the slope of the ground surface (which has an average grade of about 1:55 or 1.8 percent) the tunnel will intersect the ground surface if it is continued far enough. However, somewhat before the actual point of intersection, the tunnel becomes a narrow, open canal (Fig. 73). The nature of the soil (constituents, degree of compactness and cementation, etc.) usually dictates the depth and distance from the point of intersection that the canal is started. This canal is then extended to the areas to be serviced.

The total length of the chain well systems in the Tehuacan Valley has been estimated at 600 km. (Comisión del Papaloapan 1954: 18); however, our survey indicates that the total length of the subterranean tunnels of these systems is more on the order of 230 km. We found that the maximum length of any one system, which may be composed of one to six or seven branches of tunnels, is about 10 km. and the minimum length noted was about 200 meters. The average length of the 105 complete systems, counting all branches as belonging to a single system, was found to be about 2.20 km. These systems are, for the most part, much shorter than their Near Eastern counterparts (Butler 1933: 71-72; Cressey 1958: 36-37; Wulff 1968: 94, 99).

In cross section the tunnels range from rectangular to an isosceles trapezoid and average about 75 cm. by 1.25 m. in width and height, respectively. In the case of the El Riego system (number 464) and in several other cases, the size of the tunnel is much greater, reaching some 3.0 by 8.0 m. in certain portions. This extreme size is evidently the result of re-excavating the tunnel to keep up with the lowering water table or to tap deeper aquifers to increase the flow within the system (Brunet 1967: 81-82).

As noted above, the nearly horizontal, subterranean tunnel is linked with the surface by a series of vertical shafts or "wells." These shafts are obviously excavated before work on the horizontal tunnel begins, as described in detail below. They serve as means of access to the tunnel for its excavation and maintenance. In addition, they provide ventilation, as well as a way by which excavation and cleaning debris are removed, and through them water may be drawn from the system.

The vertical shafts are circular, square, or rectangular in cross section (Fig. 69) and about 75 to 150 cm. across. The long axes of rectangular shafts coincide exactly with the axis of the subterranean tunnel. Shafts are present at intervals ranging from about 20 to 60 m., with the majority averaging some 45 m. apart. The depth of the shafts varies a great deal within any one system, depending on how near the shaft is to the point of intersection of the tunnel and the ground surface and on the depth of the water table or aquifer being tapped.

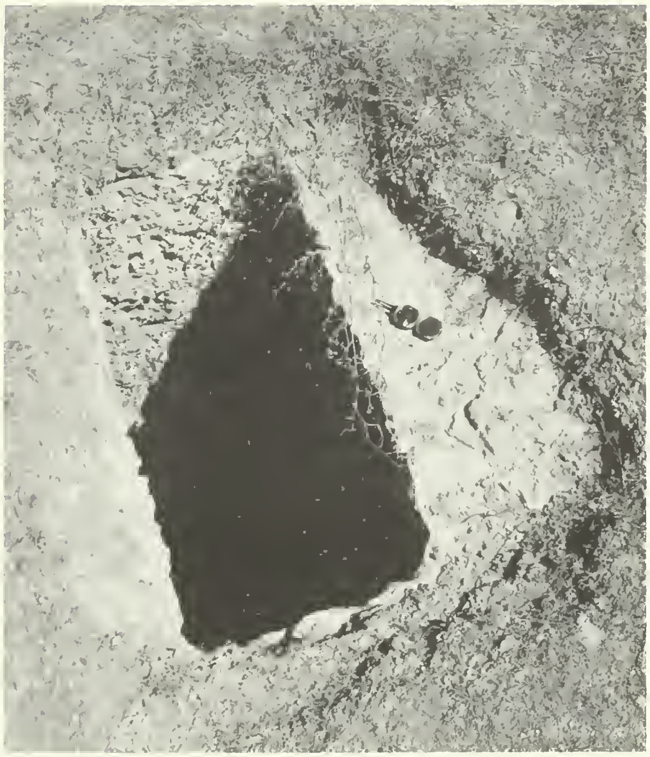


Fig. 69. Top of a well-maintained chain well shaft, in system 394.

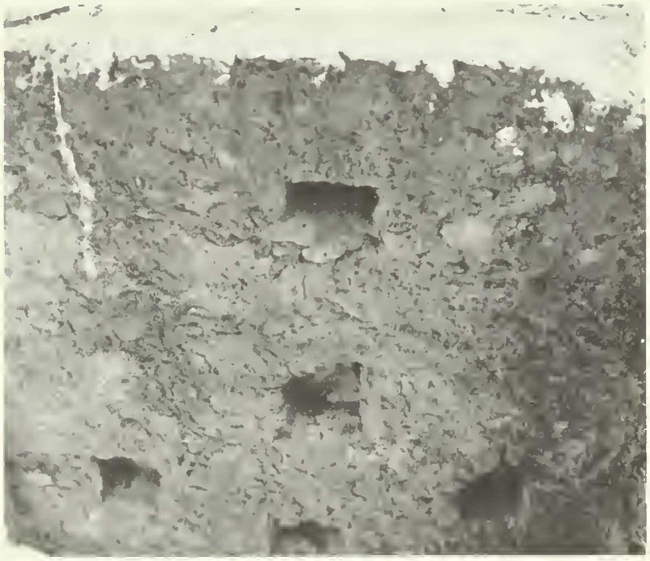


Fig. 70. Steps cut into the sides of a chain well shaft, in system 397.

The extremes of depth in the shafts measured ranged from about 2.5 to 60 m. The 60-meter-deep shafts still do not approach some of their Near Eastern counterparts which reach depths of 100 m. (Cressey 1958: 36).

Hand and footholds, averaging about 50 cm. apart vertically, were often cut into two opposing walls of the shafts (Fig. 70). We observed a few cases in which boards were inserted into these notches to act as rungs, spanning the width of the shaft and forming an actual ladder.

One final feature characterized a few of the systems located in the foothills and just inside the mouths of canyons. This was a small canal excavated either on the uphill or downhill side of the shafts and paralleling the upper portion of the system. The canal was terminated by increasing its depth by about 1.5 m. and changing its course so that it intersected the wall of one of the shafts in the lower portion of the system. This intersection took the form of a small (about 30 by 50 cm.), rectangular hole cut through the wall about 2.5 to 3 m. below the top of the shaft. This arrangement evidently augmented the flow of water within the system by adding runoff from the adjacent hillside. Apparently, the additional flow offsets the nuisance of the debris carried into the system via the canal.

Excavation and Maintenance

The following data on the processes involved in the excavation and maintenance of the Tehuacan chain well systems were obtained through interviews with well diggers and our personal observations. We are particularly indebted to Don Ysauro Carvajal (age 81) and Don Pedro Montes (age 76) for their congenial cooperation in providing much of this information. Both men have spent most of their lives specializing in the excavation and maintenance of chain well systems. In fact, for at least three generations, most of the males in their families have specialized in the same profession. At the time of our conversations both men were residents of the city of Tehuacan. Most of the data on the maintenance of the systems were derived from personally observing the cleaning of portions of systems 397 and 398 and from brief conversations with the workmen occupied at the task.

The excavation of the systems was accomplished only through the use of hand tools: spades, shovels, picks, and a short but heavy steel bar. In most cases these tools were somewhat shortened from their original forms for use in the restricted work area.

Don Ysauro stated that prior to the Revolution and subdivision of the large hacienda holdings in the region, nearly all of the chain well excavation was done by men from families that specialized in that work. Since that time, more and more of the excavations were undertaken by "sociedades de aguas" until the work was prohibited by law. These societies, each of which now maintains one or more of the systems, are for the most part composed of men, some of them related to each other, who use the water for both domestic and agricultural purposes from the particular systems they tend. In reality, their labor in the maintenance of the systems is payment for their portion of the water it provides. Both informants made a point of emphasizing the importance of having trained individuals on hand to supervise and undertake the excavations. Thus, while the members of the societies may have accomplished the bulk of the actual work, a number of trained men were always on hand to supervise and aid them.

Even with the majority of the labor being undertaken by those who would eventually use the system, the cost of constructing a chain well system is high. Our informants estimated that an average system within the valley, some 2 km. in length with a maximum depth of about 30 m. and shafts at intervals of 50 m., would cost about 25,000 pesos, or about 2,000 dollars (U.S.). This estimate is fairly close to the 30,000-peso cost quoted for a chain well system excavated in the Zapotitlan-Chilac area (Comisión del Papaloapan 1954: 28), although we do not have details regarding its length, etc., preventing a closer comparison. Wulff (1968: 105) reports a somewhat higher minimum cost ($2,200 per mile) for Iran; he gives a much higher cost for a larger system of 10 to 15 miles — $6,000 to $9,000 per mile. Although the initial cost of chain wells is high, such systems evidently pay for themselves over a period of several years. This results from its "owners'" ability to produce more and larger crops all year round and the fact that water is sold to other farmers not having a vested interest in the system or contributing to its maintenance. The cost of water apparently varies from area to area, and perhaps from system to system. One farmer we talked with in the area of Chilac stated that the irrigation his fields received from chain wells cost 75 pesos for a twelve-hour period. The Comisión del Papaloapan study (1954: 20) found water in the Ajalpan area to cost from 100 to 120 pesos for a twelve-hour period, and estimated a cost of from 300 to 400 pesos per hectare per crop.

The engineering involved in planning and digging a chain well system is relatively simple and yet quite ingenious. The first step involves a preliminary survey of the area by a "maestro" who is experienced in the planning and excavation of such systems. There then seem to be two alternative methods of proceeding, depending primarily on the characteristics of the geology and hydrology as determined by the maestro through his previous experience in digging wells in the area or by his observations of the terrain, flora, and slope of the ground surface and the geological exposures present. The first method involves the excavation of a vertical shaft from 50 to 100 m. uphill from the point where the maestro calculates the tunnel should intersect with the ground surface. Most of the subsequent work on systems initiated in this manner will proceed uphill and away from the fields. Under the second method, the first shaft is excavated where the maestro feels the best source of water is to be found. Almost all of the subsequent work on the systems started in this manner proceeds downhill and toward the fields to be irrigated. In both methods the first shaft dug serves as a test well and is deepened until a satisfactory flow of water is obtained. It is interesting to note that both methods apparently are also practiced in the Near East (cf. Bémont 1961; Cressey 1958).

The location and depths of the other vertical shafts in the system seems to be a matter of determining the spacing between the shafts and marking the intervals on a line extending downhill or uphill from the first shaft. This line is projected directly over the path of flow of water as indicated in the test well, as well as by the topography, geological exposures, and other nearby wells or springs.

Determining the depth to which each shaft was to be excavated was accomplished with nothing more than string, a stone or metal plumb bob, several stakes, and a leveling device. The procedure related to us was said to have been used on systems excavated downhill from the first shaft toward the fields. It seems likely, however, that the same technique could be used with little modification for the uphill method. The process was as follows: a string weighted with a plumb bob was extended down to the water level in the first shaft and a mark was made on the string to denote the ground level at the top of the shaft. A second string was then stretched from the ground level at the edge of the first shaft to a stake driven into the ground at the point where the second shaft was to be excavated. In more recent times this string was leveled by means of a bubble level, but earlier the leveling was apparently done by means of visual sighting — the informant was not very clear about the manner in which this was accomplished. The distance between the ground surface in which the stake had been driven and the point where the leveled string passed above that stake indicated the vertical difference between the two shafts at ground level. This distance was then subtracted from the first length of string, thus indicating the distance between the ground level and the water level in the first shaft, to obtain, within a few centimeters, the depth at which the water table would be reached in the second shaft. Later, this procedure was continued from shaft to shaft until the system was ended or until only a short distance remained between the last shaft and the point where the tunnel would break to the surface to become an open canal. It is interesting to note the similarities between the process described by our informants in Tehuacan and those related by Butler (1933: 73), Beckett (1953: 48-49), and Wulff (1968: 97) as being used in the excavation of qanat systems in Iran.

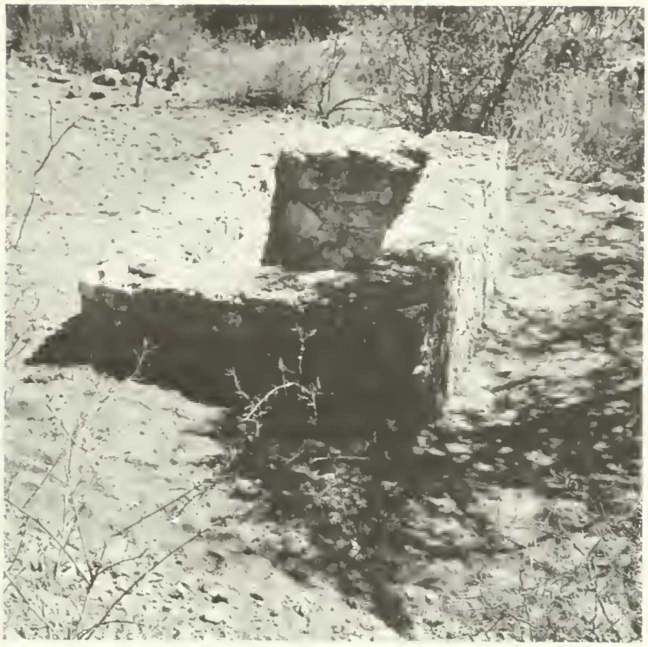


Fig. 71. The wall around this chain well shaft is an unusual addition. This shaft is the initial one in system 397.

The third step in the work was the actual excavation of the shafts. Crews of two or three men worked at this task, often rotating their jobs. One removed the earth and travertine and placed it in buckets, a second man would lift the buckets to the surface, and a third would replace the full buckets with empty ones to be sent back down the shaft and then empty the full buckets a few meters away from the shaft. Waste materials from the shaft, and from the tunnel as well, formed the characteristic circular mound of earth and travertine debris surrounding nearly every one of the shaft openings (Figs. 67, 72). We found that these rings of debris prevented wind-blown dirt and materials from water erosion from entering the system. In populated areas and locations where cattle graze, these circular mounds are quite high and steep or have been replaced by masonry walls, usually about a meter high, that immediately surround the shaft opening (Fig. 71).

The buckets of earth were removed from the shafts with the aid of two mechanisms. The most prevalent one is a triangular framework of large boards or poles

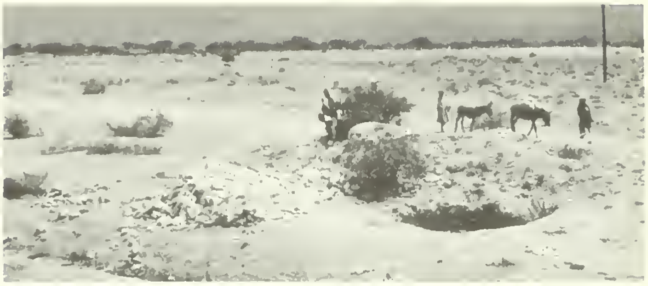


Fig. 72. Debris around a freshly cleaned chain well shaft, in the north-south arm of system 427.

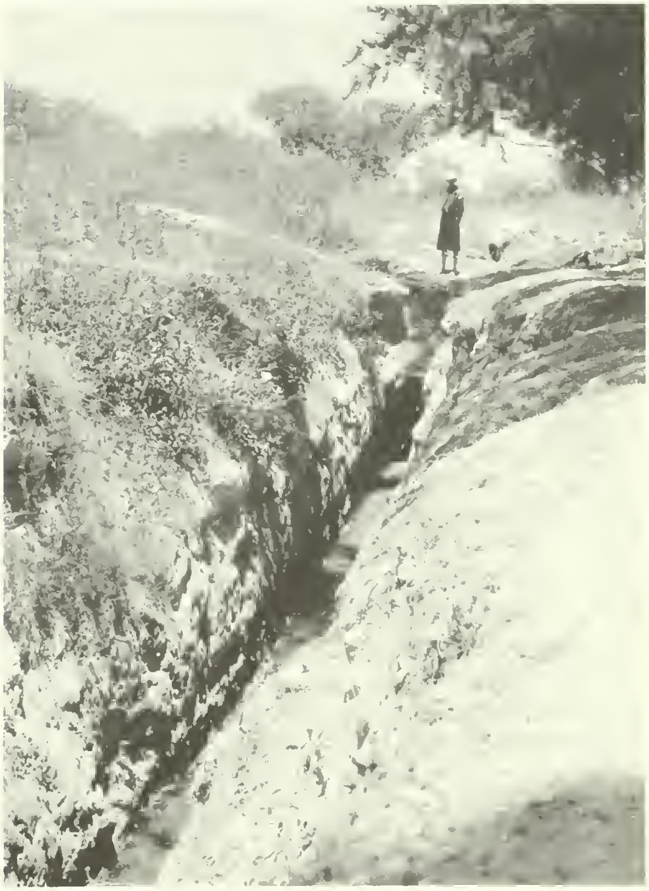


Fig. 73. At the south end of chain well system 427, the underground channel supplies an open irrigation canal, as do other chain well systems.

which supports a pulley system operated by means of a windlass (Fig. 68). This was the only mechanism we saw in use while observing the cleaning of some of the systems. We also noted some of these triangular frameworks, some with and others without the windlass, in use for drawing water for domestic use and irrigation. The second mechanism consisted only of a windlass constructed beside or straddling the shaft opening. We saw none of these in use in the cleaning of the systems. However, the presence of Y-shaped poles at either side of the shaft openings of several of the systems indicates the use of a portable windlass device that could be used in maintenance or in drawing water.

The final step in the construction of a chain well system entailed the excavation of the nearly horizontal tunnel that connects the bottom of each of the vertical shafts. At times, a number of crews could work at this task. Crews usually consisted of three men engaged in the same division of labor as that related above for the excavation of the shafts. A fourth crew member was often added to supply the excavator with empty buckets and carry the full ones from the point of excavation to the rope lift.

If the lower or downhill section of the subterranean tunnel did not penetrate the water table or aquifer being tapped, it was the first part of the tunnel to be excavated. If the system was large, two or more crews could work, either independently of one another or in two crew "teams." In the latter case, two excavators started in adjoining shafts and the men tunneled toward one another. Work in the lower section carried the tunnel downhill as well as uphill toward the first shaft at the water source. The tunnel was extended downhill until it broke to the surface as a canal. This canal was continued for a distance downhill so that water flowing into the system could be disposed of and would not collect within the tunnel. All but one excavator and his helper left the tunnel when the water table or aquifer was approached in the uphill portion of the system. This excavator continued, proceeding carefully so as not to dig the tunnel too deeply or suddenly break through the aquifer and thereby be trapped by a wall of rushing water. Don Ysauro explained that when the water table or aquifer was tapped, the workman proceeded toward the next shaft at the same slightly upward inclined angle. When the flow became stronger and there was a danger of undermining, a cave-in, or being drowned, the worker angled the tunnel upward until the flow became more moderate and then returned to the nearly horizontal course. According to Don Ysauro, only a few centimeters of upward tunneling, perhaps 50 or 60 at most, were usually necessary to regain a safe rate of flow. Each of the succeeding shafts was bailed dry as the excavator approached it, to prevent the danger of a quick breakthrough by water backed up in the well. This process was continued until the first shaft was reached. The tedious and rather dangerous process of excavating while maintaining a constant flow was necessary for the entire length of those systems in which the lower or downhill portion of the tunnel tapped the water table or an aquifer.

A number of methods were mentioned by which the excavators remained on a straight course to intersect the next vertical shaft or meet the crew tunneling toward them. Two simple sighting devices used consisted of (1) two weighted strings extending down opposite sides of a shaft and (2) two or three candles placed on the floor of a shaft and the tunnel. In both cases the excavator would align the properly located strings or candles by sight to make sure the tunnel did not vary too much to the left or right. The informants said the use of candles was preferred by most of the workers as they were easier to see, two or three of the more widely spaced candles were more accurate for vertical alignment, and candles provided reference points that helped them with horizontal alignment. One of the men cleaning System 398 mentioned a rather complicated use of mirrors (flat and concave) and sunlight, or artificial light, to provide a constant point of illumination in the center of the area to be tunneled out. He could not supply any further details as he had been told about the arrangement by a friend and had not seen it in use. Neither of our informants, nor any of the other men we asked about the technique, had ever heard of it. Not only would this rather sophisticated technique enable the men to work in the cool evenings and nights, but it would also provide a cool, non-oxygen depleting light source.

Barring emergencies, the normal maintenance of a system is carried out once or twice a year. This maintenance consists of the careful inspection of the entire system to make certain there are no indications of impending cave-ins. If such indications are found, the walls and ceiling of the tunnel are securely shored up with heavy timbers. According to our informants, such reinforcement is not usually necessary in either the excavation or the maintenance of the systems. A second phase in the maintenance procedure is a cleaning of the floor and lower portion of the tunnel walls. Calcium carbonates carried in suspension and solution by the waters in the area are deposited as travertine in the system. The process involved in this deposition is the same as that related in the previous section describing the "fossilized" canal systems of the valley. The cleaning involves the use of picks and short, heavy steel bars to chip away all but a thin layer of travertine from the walls and floor of the tunnel. The remaining thin layer of travertine serves to "seal" the channel so that little water is lost through seepage. Cleaning is done by crews of three or four men using the same equipment and working in much the same manner as in the construction of the system. The rate of deposition, which is primarily related to the rate of flow, determines whether a system will be cleaned once or twice a year. Don Pedro stated that in those systems having a good flow of water the deposition amounted to about 60 cm. a year. Such systems require two cleanings a year.

Further work is needed on a chain well system when there is a need to increase the flow of water or if the level of the water table or aquifer drops. The flow is usually increased by continuing the excavation of the tunnel uphill from the first vertical shaft in the system. Short lateral tunnels may also be excavated out from the sides of the main tunnel to increase the area that receives water from the water table or aquifer. Two other modifications are made when the water source becomes lower, although they too can be used to increase the flow within the system. One of these is the lowering of the tunnel floor for the entire length of the system. This is done so that the tunnel again sufficiently penetrates the water table or aquifer and yet maintains the proper gradient to allow the transfer of water down the system to the canals. The second modification is somewhat more drastic, as well as more expensive. In this case one or more new chain well systems are excavated as branches of the main tunnel, extending outward and upslope to increase the area of the system that receives the water or to tap new aquifers.

The Age and Origin of the Tehuacan Systems

Our field work and research has produced no evidence that any of the chain well systems in the Tehuacan Valley were excavated in prehistoric times. In fact, we have found no direct evidence that the systems date earlier than the nineteenth century, despite the tantalizing, but unreferenced, comment made by Blasquez (1957: 41):

> Las obras de esta naturaleza son de gran importancia en la region, al grado de que hacen de ella la primera en la República, por su numero y extensión. Este sistema de captación de aguas fue aplicado por primera vez, en Tehuacan, por los frailes franciscanos, casi a raiz de la conquista, cuando fue creado el marquesado de Oaxaca y desde entonces, se ha venido desarrollando la red de galerías hasta alcanzar la considerable extensión que hoy tienen.

Unfortunately, lack of time did not permit us to conduct more interviews or go through local files and documents to determine more exactly the time and circumstances involved in the introduction of the chain well system into the Tehuacan region.

Our impression that the systems are a post-Conquest introduction into the region is based on several lines of evidence. Except for the term *apantle,* derived from the Nahuatl *apanatl,* water channel (Peñafiel 1885: 56-57), the chain wells are referred to by Spanish terms. This is suggestive of a Spanish source, rather than Indian, for the technique. Second, the similarities in technique of the Mexican and the more widespread Near Eastern system suggests the latter as the source, with Spain as the link in transmittal, as discussed below. Third, the excavation of a chain well system with only the wooden and stone tools of prehistoric times would have been more difficult, perhaps prohibitively so, than with the metal tools introduced in the sixteenth century.

Nowhere did we observe a chain well system so located in relation to prehistoric architecture or materials that we could do more than suspect an association. In several cases, such as System 401 just west of Necoxtla, we found systems excavated through or fairly close to prehistoric sites. However, at least a few of the shafts of these systems had been cut through the cultural deposits and there was no evidence of occupation or deposition subsequent to their excavation. The deposits exposed in the shaft walls ranged in time from late in the Palo Blanco phase through the latter half of the Venta Salada phase (A.D. 700-1540).

Brunet's historical sketch of the hydrology of the valley casts doubt on the necessity for, and even on the possibility of, excavating chain well systems before or soon after the Conquest (1967: 81-82). His data indicate, although by no means conclusively, that prior to and shortly after the Conquest the water table was higher and thus more water was available from springs than has been the case in more recent times.

Approaching the problem from the opposite direction, we were able to trace the excavation of the systems back to perhaps 1850 or 1860. Don Ysauro and Don Pedro stated that their grandfathers had excavated chain wells, but neither could tell us if their grandfathers had done this work all their lives or if their great-grandfathers had been so employed, The informants were asked for details regarding the time and circumstances involved in the introduction of chain well systems into the Tehuacan Valley. They answered that they believed the first systems were excavated in the early 1800's and that the project was sponsored by a wealthy landowner who needed more water for his fields. They could not supply a more accurate date for the excavation, give the location of the wells, or the name of the landowner. However, both men agreed that the chain well systems in the immediate vicinity of the city of Tehuacan were more recent than those in the vicinity of Chilac, Altepexi, and Zinacatepec. Unlike the farmers we talked with regarding the "fossil" canals in the region, neither informant could remember ever hearing any rumors or legends that the chain wells were any older or had been excavated by their "antepasados" (the word the less educated inhabitants of the Tehuacan Valley use to indicate the Indian population prior to the Conquest).

Don Ysauro recalled that as a boy, when he was not busy tending the crops or doing other chores, he had helped his father in the excavation of two systems — one near Altepexi and the other near Zinacatepec. From his somewhat unclear description of the location of these chain wells, it seems possible that he worked on the systems we have designated 409 and 442. His first full-time work on a chain well was sometime between 1902 and 1904, when he worked on the north-south portion of system 427 — just south of the city of Tehuacan.

The earliest exact date we were able to apply to a specific chain well system was supplied by Sr. Gorgonio Gil Huerta. Sr. Gil is a well-known and respected elderly citizen of the city of Tehuacan. His family has lived in the region for many years and at one time had large hacienda landholdings. Sr. Gil remembered that his maternal grandfather (Sr. Manuel García Huerta) had sponsored the excavation of a chain well system located on his property just a few kilometers northwest of the city of Tehuacan. He then precisely described the location of the system we have designated 448 and stated that is was excavated in 1876. Sr. Gil had no information as to where the first system had been excavated in the valley or who had introduced the idea. His only comment was that he believed the first chain well systems in the valley were excavated sometime between 1850 and 1860.

Our all too brief inquiries and research have produced little information as to the exact source or origin of the Tehuacan chain well systems. There is some evidence that similar systems appear in South America in the arid Nasca region in southern Peru, (Mejía Xesspe 1942; Rossel Castro 1942) and Pica in northern Chile (Bowman 1924: 20-21) and that these may, at least in some cases, actually be prehistoric. After this report was completed, our impression that in Mexico chain wells occurred only in the Tehuacan area was modified by the publication of a brief but detailed report (Seele 1969) on chain wells in the Acatzingo-Tepeaca region of Puebla, about 70 km. north of Tehuacan. Although Seele suggests the possibiltiy of a prehistoric indigenous origin, no proof of this has yet been found, and it seems most probable to us that chain wells were introduced to Mexico from Spain within the last century or possibly as early as the sixteenth century. The long periods of profound influence on Spain by the Arab world and on Mexico, in turn, by Spain, make this the most probable route of diffusion, as do specific similarities of detail between Mexico and the Near East.

The historical background of the qanat system in the Old World and its early introduction to the Iberian Peninsula may be briefly summarized from Troll (1963) and other sources as follows. The earliest use of qanat systems appears to have been in the eighth century B.C., first in Armenia and slightly later at Nineveh in Mesopotamia (Forbes 1955: 152-154). The earliest use of qanats in Persia (Iran) evidently did not occur until nearly a century later, when systems were used to supply water for domestic use at Ecbatana, the capital city of the Median Empire and the present city of Hamadan, and still later for irrigation in the area of Persepolis, one of the capital cities of the Achaemenian Empire (sixth century B.C.). With the spread of the Achaemenian Empire and its sphere of influence in the fifth century B.C., the technique of qanat excavation was evidently taken to Egypt. The qanats were readily adapted to the Kharga Oasis in Egypt because of the similar geomorphological and climatic conditions of the arid mountain and basin landscapes, which were much like those in Persia. From Egypt the use of qanats apparently next spread to the central and northwestern Saharan region, where it expanded to a degree second only to its use in Persia. The expansion of the technique of qanat excavation into these areas probably for the most part resulted from the Arabian invasions of A.D. 984 and 1280. By at least the thirteenth century, and possibly as early as the tenth or eleventh centuries, qanats were functioning in the now abandoned city of Sadrata, just south of the present city of Quargla and about 575 km. south-southeast of Algiers. By the end of the twelfth century the technique had been established in the Marrakesch region of Morocco. The final link in the chain of events that eventually transmitted the idea of qanat technology to the Iberian Peninsula, and thus to the Spanish, was brought to light through the work of J. Oliver Asin (1959), a Spanish scholar of Arabic matters. Through field work and a study of the archives, Asin discovered a system of qanat galleries underlying the city of Madrid. Through documentation, Asin has verified the presence of these qanats as early as 1202. However, the system began earlier than this, as it was excavated by Arab invaders who had modified an already existing village into a fortified city. After the withdrawal of the Arabs, this became the Spanish city of Madrid. As further verification of this, Asin notes that the name "Madrid" is derived from the Spanish-Arabic hybrid name "Mayrit," which he sees as a combination of the stem "Mayra," (Arabic for "water gallery") and ending "it," which was derived from the Latin mixed suffix "etum" (Spanish "edo").

The data we have presented above should be considered introductory to further studies. There is an excellent opportunity in the Tehuacan Valley for a study of both the technology and the sociology of the chain well systems. Specifically, the time and source of this innovation would be of interest, and the factors that accounted for what appears to be a relatively rapid acceptance in spite of its distinctiveness. Relatively abundant documentation may be available in local church and private archives that have, so far, been little studied.

Another aspect of the chain wells deserving further investigation is the extent to which the *sociedades* responsible for them are also an innovation or are a modification of older, pre-existing cooperative water-management groups. Here the world-wide problem of the interaction between social and technological systems can be examined in microcosm. It would also be worthwhile to follow up the implication that formerly the skills of excavating and maintaining the chain wells rested in certain extended families and perhaps in certain towns and villages. This would present an interesting parallel to the Near Eastern situation and might also shed light on the possibilities of prehistoric technical specialization and its social and geographic restriction.

Because our time was limited and the chain wells became a larger and more complex problem the further we examined them, we have only scratched the surface of the subject. We hope others will carry the study further.

Summary

The evidence in the Tehuacan Valley and its environs for aboriginal techniques of managing water supplies is important chiefly in relation to the changing subsistence systems and settlement patterns that have been discerned by the multi-disciplinary approach of the Tehuacan Project. Therefore, much of the meaning of the water control systems described here has already been incorporated into this and the preceding volumes in discussions of the plant remains, of the sites, and of the social, economic, and demographic inferences toward which all lines of evidence have been directed. Nevertheless, it may be useful here to recapitulate some of the conclusions or implications already mentioned elsewhere and to review briefly some of the ways in which evidence on water management fits into the larger Mesoamerican picture.

The presence of irrigation farming in the Formative period has been generally agreed upon as a reasonable inference for at least fifteen years, but firm evidence has been lacking. Palerm, in a paper prepared in 1953, says, "The problem of dating the beginning of irrigation in Mesoamerica can be solved only by archaeological means. The historic sources apparently do not take it any further back than the Toltec era" (Palerm 1955: 35-36). The botanical evidence from the Tehuacan Valley makes it clear that during the Coxcatlan phase at about 4000 B.C. at least small-scale farming was being systematically carried on, producing squash, avocado, chili, some corn, and perhaps also amaranth and cotton. Since the plants being grown would require much more moisture than was available in most parts of the area, it is probable that this incipient agriculture was carried on in the deeper barrancas, to take advantage of runoff from the moister mountains to the east and also of small bottomlands with deep soil. Another line of evidence, the analysis of site distribution in relation to the topography and resources of the region, suggests that from the Abejas phase onward to the Santa Maria phase settlement was concentrating along the central waterways and on canyon flanks, which would be locations convenient to barranca farms.

Nevertheless, these indirect lines of evidence are accompanied by no identifiable remains of farms or their water supplies until the beginning of the Purron Dam complex, about 700 B.C. There must, therefore, by this time have been some three millennia of experience in the problems of planting, watering, weeding, and harvesting. We suspect that during these millennia small-scale irrigation along the intermittent streams flowing into the Rio Salado from the east would have developed a substantial body of technical skill, including the diverting of water by small, temporary barriers essentially like those still used in the Tehuacan Valley and in many other parts of the world (see Figs. 23, 24, 25). Thus it should come as no surprise that experiments in more elaborate dam building began during the Santa Maria phase. However, it is a matter of some interest that soon after this first dam was built, less than 3 m. high and impounding only a modest amount of water (perhaps mostly diverting water to a canal, and only at time of excess impounding a reserve), it was expanded to a structure of monumental size. Construction Phase 2 produced a dam some 400 m. long and 7-8 m. high, as well as Tr 15, about 550 m. long and 3-5 m. high, which perhaps served as a cofferdam. The silting of the reservoir that eventually rendered these structures useless, as well as the dams of Periods 3 and 4, was nevertheless slow enough to allow the successive dams and their appurtenances of sluices and canals to function for an estimated 900 years, that is, until approximately A.D. 200.

We know of many Mesoamerican innovations that apparently spread very widely in the course of no more than a few centuries, such varied traits as modeling human figurines of clay, erecting carved stelae, and building flat-topped pyramidal structures. As far as we can discover, however, the construction of large earth-filled dams with masonry veneer was an innovation that did not spread and continue. We conclude that in spite of the long span during which the Purron Dam complex was in use, the handicaps of silting, repeated flood damage, slumping due to excess seepage, and possibly problems of social control or management of which we are unaware, must have become apparent to the farmers of the Arroyo Lencho Diego. The intensive archaeological survey of the Tehuacan Valley failed to disclose any other such structure, and although a couple of millennia of erosion could eliminate most of any structure placed in a canyon bottom, the fact that about 90 percent of the Purron Dam complex still survives makes it probable that any similar structure would have remained in sufficient bulk to be conspicuous and identifiable as to function. Therefore, the most significant aspect of this impressive achievement of dam building, initiated early in the Formative, may be that it is a major technical innovation that failed to be diffused or perpetuated. Although irrigation increased in importance and played a decisive role in expanding food production in many parts of Mesoamerica, it appears to have been carried out by means of relatively small dams or diversion structures rather than large dams impounding the total flow of streams. Technological improvements appear to have been in the direction of transporting water from perennial sources longer distances through carefully graded canals rather than securing ever-larger quantities for storage, or depending chiefly on seasonal sources. The canals for transporting water are usually of modest size (see Palerm's description [1955:30] of a modern canal 36 km. long and only 40 cm. wide and 30 cm. deep). In fact, Mesoamerican irrigation, like that of most of the pre-industrial world, has emphasized the redistribution of live water in appropriate amounts for immediate use rather than the collection of water for future distribution.

The apparent shift to the Rio Tilapa area, some 2.5 km. to the east, which began early in the Palo Blanco phase and continued through the Venta Salada phase, suggests the possible adaptation of or concomitant shift toward the use of largely perennial water sources for irrigation. The use of small irrigation dams composed largely of perishable materials, such as those used today on the Rio Xiquila, and small canals leading from them would have provided the needed irrigation water with neither the original expenditure in labor nor the constant (and losing) struggle to maintain large dams.

The Purron Dam complex provides a glimpse, however, of the intensive development of irrigation agriculture that began to take place in the Tehuacan Valley early in the Formative – and doubtless in much of Mesoamerica (see Flannery *et al.* 1967). This was an essential concomitant of the great increase in population that was taking place simultaneously with a steady expansion in the proportion of the diet that was derived from farming. The population increase from the late Ajalpan phase to the Santa Maria phase is estimated as from 42 to 165 per sq. km. but from the Santa Maria phase to the Palo Blanco phase an increase to 1,110 per sq. km. is estimated, with a total population in the Tehuacan region of about 26,600. Although direct evidence was found for only the irrigation system of the Arroyo Lencho Diego, we can assume that the many other canyons tributary to the Rio Salado had equally intensive farming development, the only difference being that they used relatively small, impermanent water diversions which have long since disappeared. Physiographic changes in these streams during the last three millennia – both erosion and deposition – make it impractical to attempt an estimate of the total acreage in the Tehuacan Valley that might have been under intensive cultivation, much of it with two crops a year. The best clue is the substantial growth in population mentioned above. The most rapid rise in population of any period of aboriginal history in the Tehuacan Valley was made from Santa Maria to Palo Blanco times.

During the Palo Blanco phase we have evidence for one small dam (Tr 447) of a type that may have become fairly common during the last eight to ten centuries before the Conquest. This structure of dry-laid masonry filled with earth and rubble blocked the small stream flowing from Tecorral Canyon; it was about 30 m. long and 3.5 m. high. Even this type of structure had the handicap of susceptibility to serious damage by floods, a risk that probably led to a primary dependence on the type of brush and rock diversion structure seen in use at the present time.

The increasing need for agricultural products, because of both rising population and declining wild-food resources, appears to have been the stimulus in the early Palo Blanco phase that led to the development of hillside farming as a major component in the subsistence. Our evidence indicates that control of run-off and soil erosion by means of simple lines of boulders and low walls of rough masonry began on what we have termed hillside sites, and only late in the Palo Blanco phase was the technique extended to the terracing of small valleys and gullies. This pattern suggests a need to control erosion and conserve moisture on slopes already being dry farmed, rather than a search for such water as would naturally collect in small drainage systems. Of course, efficient small-scale irrigation had been practiced for centuries on streams large enough to have useful areas of bottomland. But the thin soils of the hillsides and the occasional heavy rains of the region (see Byers 1967: 60) mean that removal of the natural vegetation and disturbance of the soil by cultivation would combine to create erosion. It is hardly surprising that the idea was hit upon of controlling erosion to the extent that conveniently available materials — the cobbles and boulders of the fields themselves — permitted. The construction involved was easily within the technological capabilities of people who had been building masonry houses and facing truncated pyramids with masonry since Santa Maria times. The survival and modern use of many of these simple stone alignments and terraces clearly demonstrates their effectiveness. In areas no longer farmed they may also have continued to hold moisture and soil, and thus have aided in the recovery of the natural vegetation of the hillsides, which, as Smith (1965*b*: 110) points out, has been removed many times through the centuries of farming. Prior to long-term abandonment of a field or group of fields a fallowing system (known as *barbecho* in Mexico) may have been practiced (see Palerm 1955: 29 and 1967: 34-35), with a field in use for about the same length of time as the fallow period (two to three years for each). Conservation of soil and moisture by borders and walls would have increased the speed of recovery of fertility of fallowed fields by encouraging more rapid regrowth of natural vegetation. We can conclude, therefore, that even though we may never know the details of farming techniques employed in the terrace systems of the Palo Blanco phase, they would have contributed to the productivity of areas dry farmed and added greatly to the total farm area of the Tehuacan Valley. (See Herold 1965: 153-156, for data on the extent to which simple terraces in the Casas Grandes area of Chihuahua effectively accumulate and modify soil for farming.)

Because of the wide distribution of terrace systems in the New World (see Woodbury 1961; Field 1966), it would be premature to claim the Tehuacan hillside terraces early in the first millennium A.D. as either the "oldest" or the point of origin of all other similar New World systems. A single origin or numerous separate origins may be argued, and as yet evidence to support either premise is lacking. The possibility of an Old World origin, with trans-Pacific diffusion, has been suggested by Spencer and Hale (1961: 36) on speculative-geographic grounds, but even this suggestion is tempered with the following caution: "If clearly evolutionary sequences of terracing can be documented effectively for any portion of Meso-America, the whole complex of problems around New World terracing would be altered, and there would be a sound base for considering the independent development of New World terracing" (Spencer and Hale 1961: fn. 59).

Although we propose no "clearly evolutionary sequences," we do suggest that the introduction of field borders and terraces was an important addition to the assortment of techniques by which increasingly efficient use was being made of the soil and water resources of the Tehuacan Valley and that it was a reflection of the need to expand farming beyond the easily watered and fairly level stream bottoms where it had long been concentrated. In a general way this addition to farming techniques parallels other developments of the Palo Blanco phase, such as the greater variety of kinds of settlement and of architecture and the development of well-organized salt production and other "industrial" activities. The growing specialization of the society and its sophisticated manipulation of virtually all resources of the region are reflected, therefore, in the technical details of the subsistence base.

Our evidence, admittedly indirect and less firm than we would wish, that the "fossil canals" fed by springs in the northern half of the Tehuacan Valley were first brought into use in late Palo Blanco times is in agreement with the above impressions. It cannot be proved that these springs, which produce large amounts of water and flow with satisfying regularity through dry seasons as well as wet, were not tapped for irrigation water even before this. However, the network of canals that is preserved by mineralization seems to be at least this old, and represents a further growth of effective water distribution. If we are correct in our conclusion that the various systems fed by separate springs were joined in a single continuous network some 25 km. long, this would represent a substantial advance in the distance water could be moved to points where other natural resources — farm land, salt deposits — or growing domestic needs made it useful. Thus, man was increasingly bringing an essential commodity to places of his choosing rather than siting his activities where water was naturally available.

From the Palo Blanco phase onward there is no evidence for any significant prehistoric innovations in the technology of water management in the Tehuacan area, unless the size and engineering sophistication of the Xiquila aqueduct are considered as such. We are certain that the longer canal of 6 km. was in use by early Venta Salada times (about A.D. 700), and it is possible that it was built by late Palo Blanco times. The shorter canal was almost certainly built in the Palo Blanco period. The aqueduct system can best be appreciated in the same light as the fossil canals, a step ahead in the increasing effectiveness in moving water supplies to points of advantageous use. The Rio Xiquila, with its relatively large flow maintained by springs, probably offered unique opportunities for bringing into intensive production with irrigation land that was previously dry farmed. Although the 6 km. canal is an impressive structure, it is only an elaboration of the water-control technology that had long been achieved. It was more susceptible to damage by erosion or by collapse of retaining walls than were the many small canals flowing over more even ground — of which we now know only those preserved by mineralization. Nevertheless, like the spring-fed canal system, it appears to have had continuous use to the Conquest, some 700 to 900 years, a vital link in the elaborate hydraulic network that was achieved as a result of some twenty-two centuries' experience in the control of water resources for farming, domestic, and industrial needs.

The people of the Tehuacan Valley are still depending on the kind of system developed in prehistoric times. New crops have been introduced, and the social matrix has changed within which are apportioned the labor of building and maintaining canals and the water from them. Further studies should make clearer the ranges of size and social structure for functioning irrigation communities, although the introduction of the *ejido* system, and large-scale water impoundment and distribution by the federal government are modifying the traditional patterns.

On the technological side, the most striking post-contact innovation is the chain well system, tapping sub-surface water by means of underground channels reached by series of vertical shafts or "wells." In every detail these systems are remarkably similar to the qanat systems of the Middle East, and it is not beyond the bounds of possibility that they are a direct copy of such systems, made through contacts we have been unable to discover. That they were an invention of the farmers of the Tehuacan Valley seems improbable, and there is no evidence that the chain well system there is older than the Colonial Period. It represents yet another means within the engineering ability of the local population to secure water for their ever-increasing needs, and it may well be the only additional means that would have been within the scope of the prehistoric inhabitants if the idea had reached them. Further hydraulic innovations are now within the orbit of twentieth century industrial society, represented by the engineers and planners of the Comisión del Papaloapan.

REFERENCES

Armendaris, 1902.
Armillas, 1948.
Armillas, Palerm, and Wolf, 1956.
Asin, 1959.
Beckett, 1953.
Bémont, 1961.
Blasquez L., 1957.
Bowman, 1924.
Brunet, 1967.
Butler, 1933.
Byers, 1967.
Comisión del Papaloapan, 1954, 1956*a*, 1956*b*.
Cressey, 1958.
Dahlgren de Jordán, 1954.
Erasmus, 1965.
Fernandez Contreras, 1934.
Field, 1966.
Flannery *et al.*, 1967.
Forbes, 1955.
Gibson, 1964.
Greene, 1966.
Haynes, Doberenz, and Allen, 1966.
Herold, 1965.
Hidalgo Fuentelsaz, 1958.
Lobeck, 1939.
Mejía Xesspe, 1942.
Millon, 1954.
Millon, Hall, and Díaz, 1962.
Neely, 1967.
Palerm, 1955, 1967.
Paredes Colin, 1960.
Peñafiel, 1885.
Rossel Castro, 1942.
Seele, 1969.
Simeon, 1885.
Smith, C. E., 1965*a*, 1965*b*, 1967.
Southworth, 1931.
Spencer and Hale, 1961.
Spores, 1967.
Troll, 1963.
Twenhofel, 1950.
Woodbury, 1960, 1961.
Woodbury and Trik, 1953.
Wulff, 1968.
Zimmerman, 1966.

CHAPTER 4

History of the Foundation of the Town of San Gabriel Chilacatla

Gorgonio Gil Huerta

This short history was written in 1962 by Sr. Gil, a resident of Tehuacan, from traditions surviving in the memories of the inhabitants of the town of Chilac, as the town is now commonly called, and in the Archives of San Gabriel Chilacatla. This history was translated into English by James A. Neely; it was published in Spanish in *Tlalocan,* volume 5, number 3, pages 198-219, as "San Gabriel Chilacatla" by Gorgonio Gil and James A. Neely. It is presented here because of the significant light it sheds on traditional rights in land and water resources, and the perpetuation and modification of these traditions.

Before the coming of the Spanish to the lands of Anahuac, various tribes inhabited the Valley of Tehuacan. One of these tribes, of Aztec lineage, lived in a village named Achimalacatla; in the Nahuatl language that means "the place where they spin with the spindle whorl." These were a hard working people: in addition to the men cultivating their corn fields and the women attending to their domestic chores, they employed their free moments in spinning cotton with the spindle whorl for the manufacture of clothing for personal use as well as other apparel.

Not very far from this tribe lived a tribe composed of thirty families, all of Toltec descent. This second tribe lived in a place named Tlaxumulco which in Nahuatl means "the place thrust or placed between hills," but presently is known by the name Amatitla, which means "ceiba trees in the stony tract" (*amatl,* ceiba tree, and *tetla,* stony tract). [An alternative translation, preferred by the editor of these pages, is "place where paper is made," from *amatl,* paper, and *tla* or *tlan,* place at which (see Peñafiel 1885: 54)]. This tribe, which was also hard working, distinguished itself from others in the area by the acquisition of property and the production of spices with which it carried on trade. Because of this, it attracted the envy and hatred of the other tribes.

The Spanish conquered both tribes, their members being baptized and converted to the Catholic religion. The Spanish named the chief of the Toltec tribe Basilio Toltecas because of his Toltec lineage which was recognized as the founder of New Spain or Tenochtitlan. Tenochtitlan means "the place where the tribes unite"; *tenochte* meaning all, and *tlan,* place. His consort was named Ana Chilacatla-Momotlac. Chilacatla may be translated as meaning the "mistress of the lands of chilis and green grass — *chili,* red peppers or place planted with chilis; *acatla,* place of the lands of green grass; Momotlac, "which stoned and was stoned."

Years later, according to the documents pertaining to the founding of the town of Chilacatla, there lived a pagan Indian known only by the name of Piniauhtecatl who was the valiant chief of a large tribe in the Valley of Oaxaca. He waged constant war against Don Basilio and his tribe; the last [battle] took place on 18 March 1530. It was an unequal fight that Don Basilio could not withstand, having only the men of the thirty families against the 500 men of the enemy. They were defeated and with fifteen of their men dead they were forced to abandon their property and most of their possessions. Fleeing Tlaxumulco at five o'clock in the afternoon, after saving only thirty men and a few animals, Don Basilio and Doña Ana arrived at eight-thirty in the evening at the town of Santa María Concepción y Cueva, known today as Calcahualco. They took refuge in the home of Felipe Popoca, Juan Toltecas, and Pedro

Calcahuas, second cousins of Basilio Toltecas on his father's side.

It was evidently from this event that the names Momotlac and Piniauhtecatl originated. As Piniauhtecatl means "he who comes from Pinahuia that shames," and Momotlac means "was stoned," these names were derived from the fact that this chief shamed Doña Ana Chilacatla in the battle or battles that were fought by stoning on 18 March 1530. History marks this deed as an insult to Doña Ana and not for Don Basilio Toltecas because it was the woman who exercised the authority in the tribe and not her husband.

Santa María de la Concepción y Cueva, which tradition marks as Tehuacan Antiguo and which is presently known as Calcahualco, is the site the residents were forced to leave in order to found the present Tehuacan. Calcahualco comes from *cali*, house; *cahua*, to abandon; and *co*, place — "the place of abandoned houses." The name is derived from the huge walls of a church and heaps of stones from houses left as a vestige of this town.

Tehuacan means "to be with God," being derived from *teotl*, god; *ihua*, with him; and *ca*, is. This was the name that was used among the inhabitants of the various tribes of the valley, as yet not converted, meaning that Tehuacan was now with God and now had accepted the Catholic religion.

The events happening to Don Basilio Toltecas and his tribe in Tlaxumulco and the fact that they took refuge in the house of his cousins were recorded in the "Conocimiento de la Authoridad Eclesiastica" by Friar Francisco Medina de Santa Cruz. In accord with the Royal Certificate in Doña Ana's possession, which was issued to her by the Notary Public of the Valley of Oaxaca, Don Basilio and his people declared in the presence of Friar Francisco Medina de Santa Cruz that they had intended to live in Tlaxumulco, founded by Doña Ana (with the name of San Jeronimo Tlaxumulco). However, as they had been attacked and conquered by Piniauhtecatl and his followers, they could no longer inhabit their lands. After hearing the story of Basilio Toltecas and his tribe, Bernardo Luis de Castro, the Apostolic Notary, arranged for Friar Francisco Medina de Santa Cruz, who was Commissioner of the Indians in the region, to guide them through the region to look for a new site to colonize.

In this reconnaissance they found two springs of water that were unappropriated, and two leagues away was an agreeable area with fertile lands suitable for the cultivation of spices and corn, as that was their profession. They made it known that these lands met with their approval and were acceptable. The only difficulty with which they were confronted was that these lands had previously been in the possession of the inhabitants of Achimalacatla.

The judicial proceedings for ownership were formal, being administered by Don Mateo Payan, Notary Public of the King, in the presence of the Friar Francisco Medina de Santa Cruz. Six witnesses were present. Three — Pedro Cehua, "the one sensitive to cold," Isidoro Xilaso, "the crooked or bent one," and Felipe Popoca, "he who smokes," — were residents of Santa María de la Concepción y Cueva; the others — Xalalatzin, "he who hits the sand with his hands," Tezomatzin, "peeled hands," and Chimalpopoca, "he that smokes next to his fence," — were three of the oldest men in Doña Ana's tribe. They took an oath upon God and a cross to tell the truth in all that would be asked. The first order of business dealt with the ownership of the springs which they considered to be unappropriated, having been created by God for anyone who wanted to colonize the lands. The first spring was named Texcali, which in Nahuatl means "house of stone" (*tetl*, stone, and *cali*, house) because the depression from which the water flows is in the form of a house. The other spring, located on the surface of the ground some fifty meters from the first, was called Cozahuatl, which in Nahuatl means "water that makes yellow" (*cozahuic*, that yellows, and *atl*, water). This spring was so named because its water stained yellow the salt deposits on the walls of the canals.

The water from these springs flowed over the plains without benefit to anyone. However, Friar Francisco Medina de Santa Cruz, resolving to organize the agriculture, summoned the residents of Santa María de la Concepción y Cueva to cooperate with the tribe of Doña Ana in the construction of a canal. This canal was excavated and the portions of it that exist today are known as belonging to the Apantle Huey, meaning "old canal" in Nahuatl. It extended from the springs to a place named Axeloli, meaning "divider or separator." From this point the canal branched into two channels: one leading to the lands known at Tlatlaco Atl, which were cultivated by Doña Ana's group, and the other taking water to the fields belonging to the people of Achimalacatla. The latter fields are known today by the name of Tlacoinahuac, which means "near the midway point." This project was accomplished by groups of laborers who worked on the Mondays of each week. This custom of donating one's time and work to the community each Monday has persisted to the present.

Continuing the transactions involved in ownership, the Commission went to a forest where they found a round hill that they named Ocelotzin, which in Nahuatl means "the little tiger." They stayed to the south side of the lands belonging to the town of San Juan Atzingo, "the place from where a source of water flows," continuing then from the foot of another hill to a point that they said was called Tepetlaoztoc, which means "cave of stone." From there they went along a road that leads to the town of San Pedro Tetetla, that is today called Tetitlan (rocky place), to a crooked tree that was named Mizquiti-Coltic, which means "bent mezquite." They then continued to a large wide rock that they said was named Tecuantzatzia, signifying "the place where the lion roars," and from there they went along a culvert belonging to the town of San Jose where Nicolas Tecuanhuehue (old wolf) appeared. The party then proceeded paralleling another culvert until arriving at Venta Alta, today bordering Venta Negra. From this point they turned west along a flat little hill that they called Coyocoltepec, "the crooked and steep hill." They went north to a place named Ietlcoyunque, which means "perforated rock" and then continued at once by a path to a small hill that they called Memeya-atla (the place where the water originates or is contained). Turning along a path, they arrived at the canal called Iyaxcaatl-San Andres, signifying "the irrigation canal of the property of the Hacienda San Andres." Having located the canal, they went to the point where it is traversed by the Camino Real de Tehuacan, and there they placed a boundary marker consisting of a cross on a pedestal, known today by the name Cruztitla. They then proceeded along the edge of a hill to the point where there were two Tempesquistle trees and from there to the base of a hill they called Tepeteopa, meaning "the church upon the hill." The Commission moved onward along the irrigation ditch until arriving at a barranca, and from it they went to a hill that they named Elotepetl, "the hill of the ears of green corn." From this hill the Commission returned to a place they called Atecochtitla, "the place where the water is contained in wells," and continued through the center of a deep barranca to the place that they called Macpaltitla, which means "the palm of the hand painted on stone." Here the proceedings ended, after a pile of stones was placed at each landmark as a sign of the boundary. In order to denote the solemnity of the occasion upon receiving possession of the property, Don Basilio Toltecas, his wife Doña Ana Chilacatla and all of their followers threw stones, uprooted grass, and made other demonstrations. The Commission then returned to the town.

Some days later, Don Bernardo Luis de Castro, Notary of the King, summoned Doña Ana and Don Basilio in the presence of Friar Francisco Medina de Santa Cruz and the inhabitants of Santa María de Concepción y Cueva and gave them the Royal Certificate that was to have protected their possessions. The text of this document is as follows:

> . . . Let it be known to all men that this Cedula bears witness that I, Charles the Fifth, by the grace of God, King of Castilla, Toledo, Leon, Galicia, Sevilla, Cordoba, Murcia, Jaen, for the great goodness that I have granted as a gift to the Americans who are my Indians in all of the Mexican Province, to those who are now and will be henceforth forever in the very noble city of Tlaxcala and the very noble city of Mexico, I give and bestow upon the Indians in all of the Mexican province who are my new vassals all the villages and surrounding lands in which they now live for their enjoyment. I give and yield them the villages and places mentioned above so that they are made free and untroubled forever to have them and everything belonging to them that they may control according to their direction and command. Let no one be bold enough to take or seize these lands for any reason. Anyone who does such or reproaches me shall pay a fine of 1000 maravedis that will be arranged with my loyal men. This is my Cedula and as this is a firm and stable charter for all of the Mexican province I order it sealed with my lead seal, dating the Cedula in Madrid, the 3rd of May 1539 . . . I the King.

Friar Francisco Medina de Santa Cruz, carrying out the mission entrusted to him by the Autoridad Eclesiastica, advised Doña Ana Chilacatla, her spouse Basilio Toltecas, and the residents of Achimalacatla that their tribes must form a single town, build a chapel, and choose a patron saint. According to the Royal Ordinances these were indispensible requisites in order for the Autoridad Eclesiastica to be able to ratify the title of ownership for the lands, hills, and springs that had been given to them by Bernardo Luis de Castro, Notary of the King. Being able to depend upon his spiritual help, Friar Francisco Medina de Santa Cruz offered to persuade the inhabitants of Santa María de Concepción y Cueva to cooperate in such works, as they had done in the excavation of the canals for the waters of the spring Texli, so that the processes of the church could be carried to a happy ending.

Before this, however, wanting to erase from the memory of the inhabitants of Achimalacatla all resentment for the deprivation of their lands and the humiliation to which they were subjected, Doña Ana and Basilio Toltecas offered to treat the people of Achimalacatla with all due esteem, as if they were children of the same tribe and gave them half of the water that they had received for the irrigation of their crops.

They began the construction of the chapel on 20 August 1541, a holiday in remembrance of the glorious Abbot San Bernardo, and after two years of efforts and hardships, it was completed. Friar Francisco Medina de Santa Cruz was commissioned to notify the Autoridad Eclesiastica [that the chapel had been completed]. Accepting Doña Ana's proposal that the patron saint of that church should be the glorious ambassador of the Virgin Mary, the Archangel San Gabriel, the Autoridad Eclesiastica fixed a date for the consecration. A carved image of the saint, happily rescued from the fierce attack of Piniauhtecatl 18 March 1530, had been brought from Tlaxumulco. With a very solemn ceremony, the blessing of the chapel took place the 8th of May, 1543. The details of this festive occasion are presented in the following document.

. . . In Nomine Deus Amen . . . In the districts of the town of San Gabriel Chilacatla, the 8th of May, of the year of the birth of our redeemer Jesus Christ that for this consideration has its beginning, I give this Charter. Today, Thursday, at six in the morning, I the undersigned Notario Apostolico, in the name of the Autoridad Ordinaria y Apostolica, gave blessing to the newly constructed chapel which was started August the 20th, holiday of the glorious Abbot San Bernardo, and recently finished in this, the year of 1543. Preceded by all of the ceremonies that are ordered by the sacred rites and in the name of the ordinary and apostolic authority, I confer upon this town the Charter and name San Gabriel Chilacatla. Having the infinite goodness of our God for his great benevolence and through the intervention of his mother, our Lady, the blessed Virgin Mary, who extended her liberal and generous hand to favor the foundation, the glorious Archangel San Gabriel ordered that a choral mass be sung with all solemnity. It was sung by Friar Pedro Xigena, Friar Manuel Pardo, Friar Juan Francisco Castaño, and Friar Miguel Sanchez. The mass was received at 6:30, afterward a solemn procession was enacted, and by my order we left the chapel with all due solemnity at 8:00. At the request of the notary public for the witnessing of the juridical information, all of the people of Santa María Concepción y Cueva and some of the neighboring people that had come were put in order. The flags and standards went out before [the procession], the standards and flags engraved on one side with the image of the Archangel San Gabriel and on the other side with the portrait of Doña Ana Chilacatla. When the Indians were put in order, we left the chapel for the spring. I, the undersigned notary, gave my right hand to Doña Ana Chilacatla, and the public notary, Don Mateo Payan, gave his right hand to Don Basilio Toltecas. We then joined the other priests. Arriving at the spring, Friar Francisco Medina de Santa Cruz put on his cotta, and while placing the image of the glorious Archangel San Gabriel in the litter, the priest repeated the prayer that is befitting to the glorious Archangel San Gabriel. His illustrious lordship, showing his desire to demonstrate the good will with which he and his body of clergy had officiated, complied with that which had been requested by the noble and loyal city of Mexico, which he considered with due esteem. This was also in recognition of what he was obligated to fulfill through the regard that his body of clergy had for the illustrious Don Antonio Guevara, My Lord Bishop of Mandonedo, preacher and chronicler of Charles V, who was chaplain of the brave captain and leader Don Fernando Cortez, who was present in the discovery and conquest of the cities and towns. At the request of the above-mentioned illustrious Archbishop of Mexico, the Sumos Pontificos ordered that the magistrates cannot apprehend [individuals] in our churches or on church lands, and also ordered that we firmly guard all of the concessions, liberties, and exceptions that have been granted by the highest authorities of the church. The Archbishop confirms all of the privileges and exemptions that the King, our Lord, Charles V, has granted to the Indians in all of the Mexican province. As was the ancient custom of the Kings of Spain, he grants this privilege to the lords of monasteries or churches so they may appoint exempted people. The person appointed as exempt is free and exempt and privileged from paying the Pechos Ordinarios and other royal taxes according to the condition of the privilege that was given him. The King gave this town, belonging to himself and Doña Ana Chilacatla Momotlac, the name San Gabriel Chilacatla in the presence of the trustworthy witnesses mentioned above, who had been present in the mentioned place and will for all time be evidence of what has been narrated. *I give the water springs to Doña Ana Chilacatla Momotlac* for the irrigation and cultivation of her works and sown lands *for ever and ever as it is recorded in the royal Cedula* which is affixed at the beginning of this Charter authenticated by me *so that no one in the region may divert the water from the springs* [all italicized passages are underlined in the original] without special permission from Doña Ana Chilacatla Momotlac as founder and absolute owner of all the shores and rivers and springs and lands in the district that the King, our Lord, has given to her as a gift. He who may hinder this now or in the future for her or her successors for ever may suffer major excommunication by the canonic law, Latente Ipso Facto Incurrente Y Suspensionem Intotum; and, if punished by civil law, a fine of 1000 maravedis and everything that is included in the exemption. I, the undersigned notary, in the presence of the witnesses already mentioned and summoned by Friar Francisco Medina de Santa Cruz as deputy minister of the region, and in the presence of his own people, give possession to Don Basilio Toltecas, spouse of Doña Ana Chilacatla Momotlac, the area from the hill beside San Juan Atzingo until one arrives at a small round hill named in the Mexican language Ocelotzin; I the underwritten notary signed. Next we went around the base of a hill I named Tepetlaoztotl, then we returned surveying the San Pedro road where there is a bent tree called Mizquiti-Coltic in the Mexican language; I the underwritten notary signed. From the tree we viewed a large rock and I named it, in the Mexican language, Tecuantzatzia; I the underwritten notary signed. From the large stone we proceeded along the culvert and I named it, in the Mexican language, Atarjea del Agua de San Jose, and here appeared Don Nicolas Tecuanhuehue with all of his followers who were encountered at the boundary of his village; I the underwritten notary signed. And from those boundaries, one belonging to Don Basilio Toltecas and the other to Don Nicolas Tecuanhuehue Coscatecos, we went along the stone culvert until arriving at Venta Alta; this place I named in the Mexican language Tecomulco; I the underwritten notary signed. We then continued along a flat hill that I named in the Mexican language Coyolcotepetl; I the underwritten notary signed. Proceeding, we went up and arrived at a place that I called in the Mexican language Ietlcoyunque; I the underwritten notary signed. Then we went surveying along a straight road to a little hill, and I named it in the Mexican language Memeyatla; I the underwritten notary signed. Continuing, we arrived at a place and I named it in the Mexican language Apantle laxcaatl San Andres, and then we went out to a road where I ordered a cross built for a boundary marker. Next we went around the edge of a hill to where there were two trees, and I named it in the Mexican language Tempesquistles; immediately we went to a hill, I named it in the Mexican language Tepeteopa. Presently, we arrived at the edge of a barranca and then we went via a canyon between some large hills and we went to view a round hill, and I named it in the Mexican language Elotepetl; I the underwritten notary signed. We then returned to inspect a place, and I named it Atecochtitla; I the underwritten notary signed. Presently, we went to survey a deep barranca between some hills and we went to place a stone or large rock, and I named it in the Mexican language Tetllana-tzin. Here appeared Don Juan Chicompeso with all of his Zapotecs and they said that the stone is the boundary marker between one settlement and the other, and I named it in the Mexican language Macpaltitla; I the underwritten notary signed. Without a detail of disagreement, all underlined portions of said grant to property will be taken as faithful testimony, entrusted as the proof that this town has of its foundation. This is the Cedula of the King, our Lord, Charles V, written on parchment with the lead seal hanging from colored silk ribbons with the coat of arms of Castile and Leon and on both sides this inscription: *Carolis Illustris Regis Et Legiones*. This is to certify that this document is authentic and we issue it at the spring on the 8th of May of 1543. Signed, Bernardo Luis de Castro, Notario Apostolico, Friar Francisco Medina de Santa Cruz. Signed by me, Mateo Payan, resident of the new city of Mexico and by Royal Authority for all of the lands, realms and dominions of the King, our Lord, I proclaim and notarize all that has been said above, together with the above mentioned witnesses who are present, I signed and sealed this document as a true affidavit . . .

The construction of the present church in San Gabriel Chilac was completed in 1812, during the bloody times of the fight for independence. It is not known how long its construction lasted or if it was accomplished by voluntary or forced contributions of the residents of the town. The architect and painters of the church remain anonymous as well. One may surely suspect that upon the death of Doña Ana Chilacatla and Don Basilio Toltecas, their remains were buried within the church.

Owing to the absence of documents, the history of San Gabriel Chilacatla remains unknown for a period of two hundred years following its founding. However, history tells us that the King of Spain gave the Conquistadores estates in the cities and haciendas in the country. The Indians were treated with much cruelty. Like animals they were transferred to form a part of the property of the landholders.

This inhuman situation forced them to flee and live in the forests like beasts rather than be near their tormentors.

To lessen so much pain, misery, and slavery, the King sent knighted commanders that formed and established ecclesiastic and religious orders in the country. They relieved the hardships of the Indians and when possible they saved the lives of those preyed upon to work in the mines and do other terrible and rigorous work of the kind that the Indian could not endure because of his poor nourishment.

This knightly clergy, however, soon became debauched and, rivaling the conquistadores with their desires to become rich, they acquired ranches, haciendas, homes, pastures, and so forth. They constantly invented religious holidays in which the Indians took part with their dances, being charged for the masses, sermons, processions and blessings. These ended in drunken feasts that lasted for days and the Indians spent the little they earned.

At the time the events related here were taking place, the rule of Doña Ana Chilacatla and Don Basilio Toltecas had ended. However, their community witnessed the artificialness of their ownership when the Spanish government granted, as a gift, half of the waters from the spring Texcali. These waters were divided among the communities of San Francisco Altepexi and San Antonio Patzingo, as well as between Fernando de Monteagudo, and Bartolome Soriano, captains of war and owners of the Haciendas of Buenavista and San Francisco de Venta Negra.

In time, the usefulness of this water declined from abuse, for the owners of the hacienda ordered more than their allotted share to be taken, thereby harming the community of Chilacatla. Unyielding, Chilacatla lodged constant complaints with the administrative authorities and the superior magistrates until they were obliged to discuss a judgment, the verdict of which was laid down in Mexico City in 1641. The official communication resolved that the parties involved in the dispute were to construct a basin and spillways of lime and stone in order that the water might be divided exactly in half. The construction was carried out in this manner ending the difficulties, and may still be found in use.

The foregoing annexations produced a sorrowful impression on the spirit of the residents of Chilacatla, who considered themselves as absolute owners of the waters from the spring Texcali, because the title of possession so stated. They were further confounded when, by means of a new decree, the Spanish government gave another grant, consisting of several Caballerias of land [each of which was equal to about 33 acres] with waters from the spring Cozahuatl, to Miguel Perez de Andaballa y Santa Cruz, who was the new owner of the Hacienda de Buenavista. Located to the east of Chilacatla these were lands of the best quality. They extended east as far as the adjoining lands of San Jose, to the south to the lands of San Pedro, and to the north to the lands of the Haciendas of Venta Negra and San Andres. With these lands the Hacienda San Miguel was formed, named in honor of its founder Don Miguel Perez de Andaballa y Santa Cruz.

This hacienda existed for sixty-eight years, flourishing in agriculture, cattle, and other trades. The residents of San Mateo lent the hacienda a portion of their cattle to care for. The residents of San Mateo named the corral where the cattle were kept Tlacochicalco, a Nahuatl word which means "houses where the cattle sleep." The Hacienda San Miguel periodically carried out the Matanza of cattle [slaughter of cattle that have only subsisted on cactus and wild vegetation] at Tlacochicalco and, according to tradition, to this day the residents know the area of the cemetery by the name Matanzaco. The neighbors of Chilacatla worked in the production of saltpeter at the place named Salinatla or Salinatitla, which means "the place where there is saltpetrous water."

Unable to forget the division of their lands, the community of Chilacatla was deeply resentful. They seriously considered the case and entered into talks with the Marques de Andaballa in order to buy the Hacienda San Miguel. Reaching an agreement, the sale was contracted in the amount of 3,000 pesos in silver to be paid in two parts. The waters of the spring Cozahuatl were not included in this transaction; they were sold separately to the residents of San Jose, San Mateo, and San Pedro.

In order to collect funds, the purchasers of the Hacienda San Miguel had to sell two caballerias of land, each having two canals for water coming from the spring Texcali, to the towns of San Mateo and San Pedro. The amount of 1,000 pesos in silver was paid for each part purchased, with the understanding that twelve hours of irrigation from each canal were to be received day and night every Sunday. The water would be delivered in turn to the districts of Tlacoatl, Tlaconahuac, Ecatzingo, and Tepeteopa, as it is today. These contracts of sale were signed by Luis Perez de Orbello, attorney for the town of Chilacatla.

On the 27th of July of 1709, the community of Chilacatla paid Don Miguel Perez de Andaballa y Santa Cruz the amount of 3,000 pesos that had been agreed upon for the purchase of the Hacienda San Miguel. Taking immediate possession of their old lands, they proceeded to demolish its buildings for fear that, if they were maintained, in time some other descendant of a conquistador would covet them. Two years later only a few standing walls remained. Today this site is known by the name Tepantitla, a Nahuatl word that signifies "the place of the standing walls."

In 1711 the servants and laborers bound to this estate were, by their own volition, incorporated into the towns of Chilacatla and San Jose. They preserved, however, an impression left on them by the Hacienda San Miguel for they presently celebrate with solemnity the holiday of San Miguel and not that of San Jose. Those who joined with Chilacatla were given lands and water for their cultivated fields. This new settlement took the name Barrio de Ecatzingo, which in Nahuatl means "those who were gathered from below."

Although the difficulties that troubled the residents of Chilacatla were settled, other events were taking place in the vicinity.

During these same years, a tribe was living atop a high hill located to the west of the Hacienda San Andres. As was the practice, it was conquered and obliged to construct its church or chapel in homage to the Catholic religion. Because of its height, which dominated the entire Valley of Tehuacan, the surrounding tribes knew it by the name Tepeteopa, which in the Nahuatl language signifies "the church on the hill."

Needing pastures and forests for the fattening of cattle, a Spaniard from Tepeaca, who was the owner of the Hacienda San Andres Arrialco, tried by every means possible to rent them from Tepeteopa. However, the residents of this town, afraid of being stripped of their property, refused to consider the rental. This attitude offended the pride of the owner of the hacienda and by making use of his money, his status as a descendant of a conquistador, and his influence with the authorities, he ordered his cattle to be led into the pastures denied him. Using force of arms, he brought about unequal fights in which the natives of Tepeteopa received the worst part.

More of these disputes finally had their effect and one fateful day the hacienda owner ordered their houses burned, the chapel destroyed, and their lands taken. Pursued, the people of Tepeteopa came down to settle in the hills around the town of Chilacatla, at a place known today by the name El Xantil. Although its fears persisted, the tribe remained at this location until 11 September 1744. By this time the ownership of the Hacienda San Andres had changed to another Spaniard, also from Tepeaca, named Alonso Ruiz de Barcena. With the intent to expel the residents of the new Tepeteopa, he requested a juridical survey of his lands by the authorities of Tehuacan. Having been previously bribed, the authorities recorded false testimony at the court proceedings, to the effect that the property of this tribe was found to be within the lands of the Hacienda San Andres.

With this vindication by the court, the owner of the Hacienda San Andres continued with the same passion as his predecessor, taking their lands and destroying their houses. Fleeing this new transgression, the people of Tepeteopa joined the village of Chilacatla. Always generous, the village received them with kindness, allocating sites for their dwellings, lands for them to cultivate, and sufficient water for irrigation. For the latter purpose, work parties helped each Monday to construct the canal for these waters, with a sluice gate in the divider, Axeloli.

Thus ended the sorrowful journey of this tribe that settled the Barrio de Tepeteopa and became part of the town of San Gabriel Chilacatla.

SUMMARY

The place where the town was established belonged to the residents of Achimalacatla. The area with its lands and forests was transferred to the possession of the tribe of Doña Ana Chilacatla and Don Basilio Toltecas. Authorized by the Gobierno Eclesiastico of Santa María de la Concepción y Cueva and guided by Friar Francisco Medina de Santa Cruz, deputy of the region, they founded the new town, San Gabriel Chilacatla, which exists today. They traced out the area and indicated the place for the construction of the chapel. With the passing of time no record was kept of the numbers of parishioners who had constructed the present church, completed in 1812.

The tribe of Doña Ana and the tribe from Achimalacatla were the founders of the new town. According to the documents (from the year 1541), Doña Ana's tribe, composed of the fifteen families that survived at Tlaxumulco, was of Toltec lineage, whereas the tribe from Achimalacatla was of Aztec descent. Aided by the residents of Santa María de la Concepción y Cueva, they constructed canals for the water of the spring Texcali and divided it in half — the origin of the place name Tlatlaco-atl which in Nahuatl signifies "divided waters." The volume of water proved to be out of proportion for the small expanse of land they were able to cultivate. The surplus water continued to the towns of San Jose Miahuatlan ("the place of the ears of corn") and San Geronimo Axochitlan ("water lily"); however, they could not take advantage of it either as they had the waters of Atzompa.

Some ninety-four years later the Spanish government, seeing that the greater portion of the water flowed without benefit, granted, without permission, to the towns of San Francisco Altepexi, San Antonio Patzingo, and the haciendas of San Francisco de Venta Negra and Buena Vista, half of these waters. Chilacatla thus suffered the first reduction of its holdings.

Sixteen years later, in the year 1651, finding in the same manner the greater portion of the lands uncultivated, the Spanish government granted several caballerias of land to Señor Miguel Perez de Andaballa y Santa Cruz. With this land he established a hacienda which was called San Miguel. This hacienda was settled and farmed in the same location, that by tradition, we presently know by the name of Tepantitla.

As has been said in another part of this account, sixty-eight years later the town of San Gabriel Chilacatla regained possession of this property by purchasing it from the owner. Fearing that the hacienda would be coveted by some other Spaniard, the town ordered that the settlement be demolished and invited the laborers bound to the hacienda to join their community, forming the Barrio de Ecatzingo.

This brought about a new distribution of the waters. One part, for Doña Ana's group, was known by the name Tlaco-atl; another, for the group of Achimalacatla, received the name Tlaco-inahuac (meaning "near the midway point") as it was located near Tlaco-atl. The last portion went to the laborers from the Hacienda

San Miguel at Ecatzingo, which means "those who have come from below."

Finally, thirty-three years later, in 1744 the people of Tepeteopa were invited to join the community of San Gabriel, as the residents of San Gabriel felt compassion for the tribe that was being persecuted by the owners of the Hacienda San Andres Arrialco. The people settled them in the western part of the town and allocated lands to them. Although these lands were uncultivated, they could be improved to resemble the best lands in the possession of the three preceding groups. This generosity once again was evident in the manner in which the water was divided into four parts; the part corresponding to the new group was henceforth known by the name of Tepeteopa.

Chronologically, thus were established the groups of Tlacoatl, Tlaconahuac, Ecatzingo, and Tepeteopa within the limits of their respective awarded zones. With the passing of time they achieved the category of Barrios. In 318 years of existence their population had grown considerably to the point of erasing all vestige of the limits of their boundaries. In 1861 the government of the State of Puebla raised them to the rank of "town," with the name Municipio de San Gabriel Chilac, deleting "acatla."

CHAPTER 5

Irrigation and the Socio-Political Organization of Cuicatec Cacicazgos

Eva Hunt

THIS WORK is dedicated to the beloved memory of Don Roberto Weitlaner, gentle teacher, wise friend, and generous colleague.

Any work of research always owes its birth to more than its official author. The Ingeniero Weitlaner not only supervised my first short trip to the Cuicatec while I was an undergraduate, but encouraged me all the way to return there to work more extensively. The list of my debts to him is too long to be enumerated. Most of the time it is impossible to include all of those people who made the labor possible. The list which follows is a minimum picture of the individuals to whom I am indebted for aid at different stages of my work.

In Mexico City, Professor Jiménez Moreno, Barbro Dahlgren and Yólotl Gonzales were helpful with advice and in locating significant sources of data, which, although published, were difficult to consult. Professor Pompa y Pompa allowed me to consult Paso y Troncoso's manuscript copies of the eighteenth-century relaciones. The late Dr. Davalos, of the INAH, benevolently granted permission to my husband and myself to work on the Cuicatec region. D. Arturo Gomez Jimenez was extremely helpful in paleographing two major documents from the collection of the IIH. Honorio Mendoza M. facilitated the process of obtaining microfilms of special documents from the AGN. Both these men gave me responsible assistance in data gathering. Pedro Armillas gave us invaluable help in a brief archaeological survey of the site of Cuicatlan.

Dr. Isabel Kelly nutured us, gave invaluable information on the Mexican academic scene and provided me with copies of Burgoa's works, which I will cherish and use for years to come.

Dr. Howard Cline of the Library of Congress handsomely provided me with technical advice and with photocopies of pictorial manuscripts which were otherwise unavailable in this country or in Mexico. Following his liberal style, the librarians at the Ayer Collection of the Newberry Library were more than patient in locating codex lithographs and other rare materials which I consulted on a regular basis, and they carefully preserved my rights of access to them.

But once a work is put together, it is still like a very rough stone. To bring out its lights it needs careful polishing. This is in part the work, not only of an author, but of his friendly and rigorous critics and editors. Dr. Robert M. Adams of the University of Chicago and Dr. Edward Calnek of the University of Rochester read the manuscript at early stages of drafting, and were incredibly generous of their advice and commentary. They never forced their ideas upon my work, but seriously took me to task when necessary to clarify my own thinking and writing. They are in no way responsible for the shortcomings of this monograph, but I am sure that whatever virtues it has belong in part to their extensive notes and criticisms.

The work was conducted with the generous aid of the National Science Foundation Grant GS87. We acknowledge also the interest and patience of Doctors Spaulding and Smith.

Finally, I would like to thank Frederick Johnson and my husband, Robert C. Hunt. Fred was an indefatigable editor, far beyond the call of duty. Robert

Hunt shared with me the total growth of this work. We discussed it together from its beginning to its final form. Many of my ideas would never have come to light without his intellectual probing and scientific honesty. But that is one of the significant side benefits of being his wife.

When I went into the field in 1963 with my husband, we decided to spend some time in the archives in Mexico City gathering historical data, a dimension sadly missing in most social anthropological studies done in Mexico. It was at this time that we found, by accident as many anthropologists do, that we had an interesting and complex situation which, by combining work in the field with analysis of unpublished documents, permitted a study of a contemporary irrigation society.

In 1964 we found Dr. R.S. MacNeish in Tehuacan in the last stages of his field research on the Tehuacan Archaeological-Botanical Project. At that time the Purron Dam, a major archaeological irrigation feature, was a subject of heated discussion. The scope of our talks naturally broadened to include the whole subject of irrigation, and as a result of these conversations in MacNeish's headquarters I decided to write a brief article on sixteenth-century Cuicatec irrigation. This paper is the result of that projected brief account. Before describing its development and my own involvement with the literature, I should say here that the theoretical concerns which originally prompted me to write this work are now somewhat irrelevant, having in part been made obsolete, in my mind, by recently published and some as yet unpublished archaeological research.

The nature of political leadership and its relation to irrigated agriculture has been posed as a crucial problem for research and is necessary to the understanding of the development, maintenance, and expansion of civilization in Mesoamerica. (See Adams 1966; Armillas 1948, 1949, 1961; Palerm 1954, 1955; Palerm and Wolf 1957; Sanders 1956, 1963, 1965; Wolf 1959.) Some of these authors have lucidly claimed that control of surface and ground water has been a crucial factor in the evolution of Mesoamerican social organization. However, there are disagreements as to the function of water control in the socio-political system. When we began this study the data available pointed to neither a confirmation nor a refutation of Wittfogel's hypothesis, one of the major areas of controversy among students of Mesoamerican culture history (Wittfogel 1957*b*). As a developmental scheme for Mesoamerica, Wittfogel's theories "did not fit comfortably," for Mesoamerica seemed to have its own peculiar character, and the dates for the introduction of irrigation were still highly tentative. This suggested that the introduction of irrigation was a later development than the appearance, not only of an autocratic state, but of any sort of state at all. Archaeologists and ethnohistorians agree that the distribution of water for irrigation occupied a prominent if not well-understood role in the dynamics of Mesoamerican society, but hypotheses were varied and specific well-documented studies were scarce or absent.

It is surprising that few studies have focused with any degree of intensity on the research necessary to elucidate the role of irrigation in any specific Mesoamerican sub-culture. Most archaeological, ethnohistorical, and modern works touch upon the subject only marginally or discuss it in the general context of Mesoamerica as a single, if not homogeneous, culture area. Moreover, and this is usually true in general works on the development of Mesoamerican civilization, irrigation may be discussed only in the context of the higher civilizations in or adjacent to the Valley of Mexico, especially the Colhua-Mexica region. In other discussions documentation is heavily, if not exclusively, based on published sources from only a few regions of major historical interest or, as in two cases (Millon, Hall and Diaz 1962; Kelly and Palerm 1952), purely on contemporary cultures. Ethnohistorical work is still sadly missed.

Palerm (1954) has pointed out at least 400 references in early Spanish sources to irrigated communities. Among these, and somewhat isolated from the major regions in which irrigation was widespread (in practice if not in hectares), are the Cuicatec settlements which formed a nucleus of irrigated communities (see Fig. 75). In this work we propose to take a close look at Cuicatec irrigation during protohistoric times.

I have, however, another related aim which is less ambitious: to describe the general character of Cuicatec society from a socio-political point of view and, insofar as possible, to relate both topics to each other. My definitions of political power, process, and so forth follow Swartz, Turner, and Tuden (1966) who emphasize the public or communal goals rather than the regulation of interpersonal affairs in general as does Sahlins (1958). However, I have incorporated Sahlins's "ceremonial" variable as an aspect of political process because it is manipulated in an isomorphic fashion in societies in which church and state are not clearly differentiated.

The Cuicatec were a loosely integrated ethnic and political unit, formed by several town — or village — states of Cuicatec speakers. They were a small, provincial society, a part of the mainstream of Mesoamerican civilization, although somewhat isolated both geographically and culturally from vigorous expanding empires. In spite of its alleged marginality it was a wealthy and flowering nucleus of provincial civilization, a cornerstone of which was their intensive, irrigated agriculture, adapted to an especially harsh ecological area. Linguistically distinct and geographically bound, they also maintained political autonomy until the period immediately before the Spanish Conquest.

However, they have been practically untouched by anthropologists, either as an historical or as a contemporary ethnic group, a dubious honor which they share with most of the other geographically or linguistically defined populations of Mesoamerica. Robert Weitlaner (1961) prepared a series of charts on contemporary ethnographic materials which may bear on ethnohistorical reconstruction, but a full analysis of these was unfortunately not completed before his death. My attempt here is based primarily on analysis of evidence available through both published and unpublished documentary materials and related sources, principally for the period immediately before the Conquest and the beginning of the Colonial Period. (See reference lists at the end of the chapter.) Documentation from this area provides interesting and valuable comparisons with high-culture groups such as the Mixtec or Aztec. Furthermore, invaluable data on the role of irrigation in a Mesoamerican society for the Postclassic, protohistoric period comes to light. This is the first such empirical study of an area outside the nuclear central valley and I believe its major contribution will be to provide materials for future comparative analysis.

Sources of Documentation

The published sources include the Relaciones Geográficas of the sixteenth century in the *Papeles de la Nueva España* (Paso y Troncoso 1905), hereafter referred to by the now standard *PNE*, and Bernal (1962). Of the relaciones, three deal directly with the Cuicatec: Navarrete 1579; Mezquita 1580; and Gallego 1580. We have also used the Relación de Obispados de Oaxaca . . . (Garcia Pimentel 1904), hereafter referred to as R. de O., and Burgoa (1670 and 1674). Although the latter wrote at a later period, his researches are a major source of chronological data for the state of Oaxaca, and can, for some purposes, be considered a primary source (cf. discussions by Cline 1961 and Bernal 1965*a*: 791). Other sources, such as the Bulletin of the Archivo General de la Nación (AGN) in Mexico, and the *Epistolario de la Nueva España (ENE)* (Paso y Troncoso 1939-42), also contain sporadic information.

Unpublished manuscripts were consulted from the Archivo General de la Nación, the Instituto de Antropología (INAH), the Instituto de Investigaciones Históricas (IIH) in Mexico City, and in the local archives in Cuicatlan and the Cuicatec villages. Professor Howard Cline of the Hispanic Foundation Manuscript Collection, Library of Congress, generously made available to us some unpublished documents and copies of unpublished codices. Rare sources were consulted in Mexico and the Newberry Library. Of the AGN, the Ramo de Indios and Ramo de Tierras have been the most profitable. Another unpublished relación, in the Latin American Manuscript Collection at the University of Texas, was unfortunately not available for consultation. This contains codex maps and one other unpublished relación connected with our area, but, since it is apparently a slightly different version of one published by Paso y Troncoso, we believe its unknown significance will not alter our interpretations.

The IIH has provided us with the most valuable early document: an extensive manuscript dated 1562 on the subject settlements of the Cuicatec state of Papalo. This source appears under the title "Informe sobre el Pleito que Doña Catarina Salome Cacica de . . ." in the references, hereafter referred to as IPCCS. It was originally obtained by Robert Weitlaner in the Cuicatec village of Concepción Papalo and added to the National Museum collection. Since then the original has been misplaced (or lost). A microfilm copy, however, is extant in the Archives of the IIH. A copy of a transcription obtained by us has been deposited in the Institute offices at Chapultepec and can readily be consulted. Throughout the chapter, numbers in parentheses refer to the Notes at the end of the chapter which document in the original Spanish the appropriate quotations from the IPCCS. Page references following the quotations are to the transcribed copy since the original is not paginated. Although other sources have references to the Cuicatec before Spanish entry, this particular manuscript is invaluable because, in certain matters, it refers to the periods before the Aztec conquest of the Cuicatec.

The manuscript contains varied information: genealogies of *caciques* (rulers), location of settlements and their agricultural lands, lists of local tribute and customary collection procedures, rules of succession, and so forth. There are two distinct components to this document. The initial sections of every sub-section are formal statements of the Spanish authorities, written in the legal idiom of the times. These statements are followed by the accounts of native witnesses. Highly formalized and repetitive, they are based on pre-Hispanic oral traditions of the Cuicatec states. (For a discussion of the relevance of oral traditions, see Vansina 1965 and 1967.) In general, the document contains two themes. Its manifest theme is a clarification of the position of two kinsmen who claim legitimate succession rights over the traditional leadership of a community, as local caciques. For this specific purpose the case was brought to the local Spanish court and native witnesses were called to produce evidence to support their claims. The underlying theme, which is the core of the dispute, is a clarification of the traditional rights of local communities, and of their cacique as an administrative figure, to control the lands and water of a particular territory for their own usufruct. The lengthy accounts of native witnesses provide us with a starting base for our analysis, adding other documentation and the modern information on geographical features, climate, and the general ecology of the region, as well as information from later periods which bears on our problem. All other unpublished sources used are described at the end of the chapter.

At present there are no published analyses of the archaeology, ethnohistory, or ethnography of the Cuicatec region that are directly relevant for our task and time period. However, there are a few articles on topics of modern anthropological interest that have been published recently or are in press (Weitlaner and Holland 1960; Holland 1959; R. Hunt 1965, 1968, and 1971; Hunt, Hunt, and Weitlaner 1968; Hunt and Hunt 1967 and 1968; E. Hunt 1969.) A recent brief summary of ethnographic features can be found in Weitlaner 1969. Three ethnographic accounts of the "tribe" have been published, all decidedly meager in quality and all failing to produce any sound analysis of historical data (Adan 1922; Basauri 1928; Cerda Silva 1942). The earliest vocabulary obtainable for the language group is post-Colonial (Belmar 1902). The Reyes (1593) or the Alvarado (1593) of the Cuicatecs have not yet been found, although we know that at least two priests during the sixteenth century spoke the language (Icaza 1925: 54; R. de O.: 96; *PNE*, IV: 188).

Whenever it seemed legitimate to do so, we have also made use of data from post-Hispanic sources of later dates, or from secondary published sources (e.g., Villaseñor y Sanches 1748; Martinez Gracida 1883; Gay 1881). Local histories have sometimes provided bits of information which seemed reliable but they have been used with extreme caution. Most historical sources after Martinez Gracida primarily repeat or distort previous evidence (e.g., Taracena 1941). Finally, we have used contemporary published research on the geography, hydrology, botany, zoology, linguistics, and economy of the region, and modern historical interpretations which touch on Cuicatec materials (e.g., Mapas Estadísticos and other works of the Comisión del Papaloapan (1956*a*); Jiménez Moreno and Higuera 1940).

A major gap in our analysis is the absence of adequate archaeological documentation for the Cuicatec. With the exception of Pareyon (1960) who excavated on the site of Quiotepec, the Cuicatec region is virgin territory. Seler-Sachs (1912) and Rickards (1926) wrote articles on the pottery and architecture, but both are minimal notes of little use for modern purposes. Weitlaner (1955 unpublished) uncovered a small mound and tomb on the northern frontier and gathered some surface pottery in Cuicatlan, stored now at the National Museum of Mexico. A small surface collection obtained by us has been preliminarily analyzed by MacNeish. A. McPherron made a brief survey of some sites in 1965 but the results are not yet available. In 1967 Armillas kindly consented to spend a week surveying Cuicatlan with R. Hunt. The results of this productive trip are incorporated in this paper. Pareyon's data have been tentatively interpreted by Caso (1965*a*; 1965*b*) and Bernal (1965*a*), but unfortunately their evidence is not directly relevant to our main task. Intensive work on the archaeology is needed to determine the validity of hypotheses, made on the basis of ethnohistory and a brief archaeological reconnaissance, about settlement patterns, land utilization, and cultural connections outside the area.

Only a complete synthesis of ethnohistorical as well as archaeological materials from all sub-cultures of Mesoamerica will give us an empirically-based approximation of the complex development of such a large and heterogeneous culture area. As Adams has pointed out, this "filling in" of the relevant pieces of the puzzle may show that "the particular sequence (of an evolutionary scheme) . . . will demand revision of the general scheme itself, or at least of 'explanations' offered for other areas in light of the variation thus documented" (Adams 1956: 231). In this respect, it is necessary that not only the major linguistic and political groups (such as the Aztecs or Maya) be investigated, but that all sub-cultures, even marginal ones, be fitted into the total picture. Otherwise, synthesis would be no more than sophisticated but undocumented hypothesis.

Our work could not have been completed without our own field research in 1963 and 1964 on the contemporary social anthropology of Cuicatec communities. As part of our project, which involved a regional study, we investigated the role of irrigation in the contemporary situation. Our knowledge of local topography, present-day irrigation techniques, the social organization of groups controlling water, community localization, and land and water conflict for the Colonial, independence, and post-Revolution periods, as well as the presence of archaeological remains, have all been useful aids in our interpretation. This work is an outgrowth, to a certain extent, of our initial interest in extending our contemporary analysis of social structure to earlier times. In future publications we will attempt to close the gap between the seventeenth and the twentieth centuries.

Geography and the Ecological Setting

The region occupied by the Cuicatec is part of the Ex-Distrito of Cuicatlan, in the northeastern part of the state of Oaxaca. The area is part of the Upper Basin of the Papaloapan, one of Mexico's largest navigable rivers and the site of a modern economic development program of the Mexican government, similar to the TVA (Poleman 1964). Speakers of four aboriginal languages, Mixtec (25%), Chinantec (9%), Mazatec (7%), and Cuicatec (45%), live in the District. The remaining 14% are monolingual Spanish speakers. These percentages have been derived from analysis of census materials of the Mexican government combined with our personal knowledge of dialect distribution in the District and State. The first three groups are found primarily in other regions. The Cuicatec, however, live only within this territory as they did largely at the time of the Spanish Conquest. Today they number over 20,000 and are the dominant linguistic group in population size and territorial expanse, as they were in the past. Mixtecs and Chocho-Popoloca occupy, as they did in the past, the western and southwestern frontier, Mazatecs the north, and Chinantecs the east and southeast. Zapotecs lived in a small corner of the southern boundary (Fig. 74).

The District of Cuicatlan comprises a distinct geographical niche separated from the rest of Mexico by major tributaries of the Papaloapan River to the northeast and mountain ranges to the west. The area is bounded on the north by the deep narrow canyon of the Rio Santo Domingo. Formed by the confluence of the Rio Grande flowing north and the Rio Salado that flows south from the Tehuacan Valley, the Santo Domingo (or Rio Quiotepec) flows east to join the Rio Usila flowing into the Papaloapan. To the east and southeast, the area is separated from the Lower Basin of the Papaloapan by the Chinantec lowlands. The west and southwest are bounded by the Almoloyas and other mountain ranges. These are the sources of the Rios Apoala, Vueltas, and Tomellin, major tributaries of the Rio Grande flowing north and forming the western boundary of the District. The Almoloyas mountain range separates the Cuicatec from the Valley of Oaxaca; passes over this range lead into the southern Etla region.

The region in which the Cuicatec themselves lived is one of distinct ecological characteristics. From the canyons of the Rio Santo Domingo and Rio Grande (La Cañada de Cuicatlan or Tomellin) at 500 to 600 meters above sea level the terrain slopes up to the uninhabited Llano Español plateau at an elevation of about 3,200 meters, and the Cerros Cheve, Rayo, and Prieto (Fig. 74). The area to the east of the plateau that is occupied by the Cuicatec lies at about 1,000 meters above sea level and is bounded by the Rio Usila flowing northeast through the Chinantec lowlands to join the Rio Santo Domingo into the Papaloapan. The Rios Grande, Santo Domingo, and Usila collect the waters of all the tributary streams descending from the Llano Español.

The Ex-Distrito is made up of five geographical-ecological areas. The western mountain zone is the dry piedmont of the high Mixtec country. Only the Rio Grande canyon is occupied; the nearest communities to the west are highland Mixtec towns. The eastern section, mostly territory occupied by the Chinantec, is temperate tropical country located on the rainy, moist side of the mountains with a mean annual temperature of 23°C and an average annual precipitation of 2,000 mm. The Central Massif is a region of evergreens; it is a cold country, sometimes covered with frost and snow. The western flank is temperate, located in the rain shadow of the mountains. The upper slopes are covered with a sparse primary forest of deciduous trees and secondary grasses. Lower down semi-arid conditions prevail. The canyon or Cañada of the Rio Grande is semi-arid, supporting a xerophitic vegetation consisting of such plants as mesquite, thorny bushes (*cardoneras*), *cuajiote*, *palo mantecoso*, hard grasses and *organo* cactus. The mean annual temperature is 25°C and the average annual precipitation is less than 600 mm. Cuicatlan itself in the Cañada receives only 298 mm. of rain (Bravo 1960). In the dry hot season, however, temperatures commonly reach 35°C to 40°C. (Cf. *Atlas Climatológico e Hidrográfico de la Cuenca del Papaloapan* (Comisión del Papaloapan 1956*a*) for a detailed analysis of climatological and hydrographic factors.)

The slopes of the Llano Español and the piedmont area are interrupted by small plateaus, barrancas, narrow depressions, and ravines cut by streams. These small rivers are the major sources of water for Cuicatec irrigation, and were so at the time of the Conquest. The

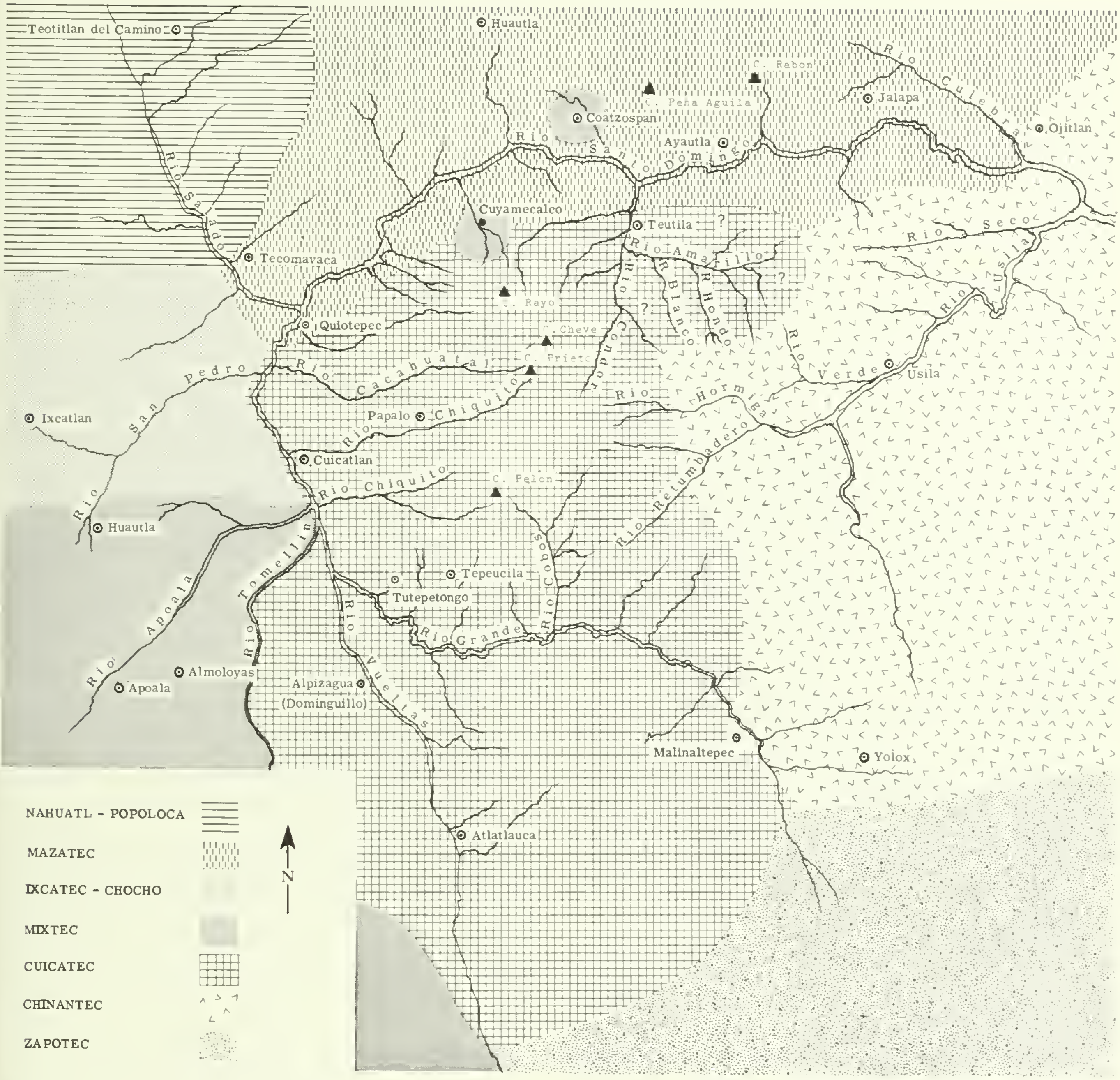


Fig. 74. Map of Cuicatec language areas ca. 1560.

location of water courses seems to have determined the location of human settlements then as well as now. In order to fully understand the social organization of the Cuicatec it is necessary to understand, first, the natural distribution and characteristics of the water supply, and second, the ways in which the social structure was influenced by the need to control water. Because virtually all our evidence for irrigation comes from the Rio Grande and the eastern section of the Cañada, detailed discussion of water distribution and management will be confined to these two areas.

Basically, there are two ecologically different water zones with irrigation, the semi-arid Cañada de Cuicatlan and the high temperate mountains to the east. The semi-arid Cañada is characterized by a low rate of rainfall and by the large permanent river, the Rio Grande.

The affluents of the Rio Grande are shallow, narrow mountain rivers with steep gradients which deposit a rich soil at their confluence with the main river. Habitation in the Cañada is found only in association with these alluvial fans, in locations where the canyon opens out into a relatively wide valley floor. Elsewhere the terrain is rough, non-irrigable, and uninhabitable. Of the towns and villages located in these fertile localities, all but one, Valerio Trujano, had pre-Hispanic antecedants.

These relatively flat alluvial flood plains are intensively cultivated. Their fields produce maize at the rate of 800 to 1,500 kilograms per hectare. Also, plums (*obos*) are raised, as well as chicozapote, mango, chile, tomatoes, some rice and fodder. Sugar cane is grown on fields irrigated by a gravity irrigation system, taking water from the main stream of the Rio Grande.

In the western flanks, either rain or, in the drier sections, irrigation, supplies the water for agricultural purposes. True rainfall agriculture is not possible below 1,200 to 1,300 meters; however, the amount of rain that does fall above this altitude, although relatively small, does help to support agriculture, as do the small permanent streams that originate in the heavily wooded mountain peaks surrounding the Llano Español (Central Massif).

Above the Cañada region, the lower ranges of the hilly flanks are unusable for agriculture. Such localities are richest in edible varieties of wild plants and small animals. Varied wild seed-pod species and *pitahayas* are still gathered here by the very poor. In earlier days this area was inhabited by hunters and gatherers living in rock shelters (MacNeish, pers. commun.). A thin vegetation is a mixture of the forest and plants found in the richer areas above and below.

The mountain towns at altitudes between 1,500 and 2,000 meters are located on small, flat areas or plateaus or on spurs alongside the streams. They use the lands above and around them for seasonal rainfall crops. The land is cultivated by an outfield-infield system which produces maize at the rate of 400 to 600 kilograms per hectare. The people here also raise some agave and peach and walnut trees. The size of the areas irrigated is very small; sometimes only two or three parcels of land support an equal number of households. The largest irrigation areas on the mountain slopes today belonged to the settlements of Papalo, a cacicazgo in the pre-Hispanic period, and are controlled today by settlements with pre-Hispanic antecedents. The primary wild vegetation here is mainly ash tree, deciduous oak and evergreen oak (*encino* and *roble*) and agave.

Above 2,000 meters are some high altitude agave plantations. Otherwise, a mixed forest provides firewood and lumber for house construction. Extreme mountain climate prevails at the upper elevations where several species of pine *(pino blanco, ocote, pino amarillo)* are the source of cellulose used by the Tuxtepec Paper Co.

During the hot dry season from December to the beginning of April, water for irrigation is scarce. Several factors besides lack of rain increase scarcity. Sizable amounts of water are lost by evaporation and absorption. Part of the stream beds are porous sand and loose stone, and in some cases forty percent of the running water is lost (pers. commun., Papaloapan Commission engineer, Tehuacan office). As might be expected, water in this area is and was extremely valuable, and the need to control water supplies was a strong influence on the social structure in the protohistoric past.

Major routes of communication with the outside tend to follow the geography. The Cañada de Cuicatlan of the Rio Grande is bounded on the south by a semi-arid mountainous region. North of the Cañada area the land ascends in a series of natural terraces into the Tehuacan-Puebla valley. To the west the land is semi-arid and the upward slope to the altitudes of the Mixteca Alta towns is steep and some ten kilometers long. In an easterly direction the land inhabited by the Chinantecs is characterized by swampy flatlands and heavy tropical forest. Aboriginal transportation in the jungle areas and along the huge rivers bordered by swamps was difficult before Colonial times when travel by boat became common. At the altitude at which the Cuicatecs live the rivers are not navigable. Friendly Indian relations with other groups, as well as political jurisdictions and economic exchange, move more often in a northerly and northeasterly direction towards Tehuacan and Veracruz rather than south towards the centers of southern Oaxaca and its capital. Thus, even though the Cuicatec have been politically attached to Oaxaca since Colonial times, their major interaction has been with the settlements in the states of Puebla and Veracruz. During most of the Colonial and independent periods, the Cuicatec were economically and politically attached to Teotitlan del Camino to the north (Esteva 1913: 93; Boletín del AGN, Div. Pol. de la Nueva España, Real Ordenanza de Intendentes 1786: 338). Since Indian communities had a certain amount of autonomy and were partially independent of the provinces to which they attached themselves, a general tendency to favor socio-political connections to the north rather than to the west or south seems indicated. It is significant that the latter two sections were occupied by Chinantec, Zapotec, and Mixtec (cf. later discussion), but for reasons of geography, the southern communities were more difficult to reach. This, again, seems to have been a determinant of towns' jurisdictions (e.g., AGN, Ramo de Tierras, Vol 10 [Cuad. Primero], Exp. 252; Vol. 675, Exp. 4).

In pre-Colonial and early Colonial times this northward orientation may have been the result not of geography but of an attempt on the part of the Cuicatec to maintain political and economic independence from the powerful Zapotec and Mixtec cacicazgos west and south of them. The Cuicatec had been ancestrally related, or may have been politically subject to these cacicazgos, but nevertheless interaction was highly antagonistic. At present, even though Cuicatlan, the headtown, and other municipios in the District belong to the state of Oaxaca, the populations tend to "face" northward, as in older periods. Today, this is reinforced by the railroad links to metropolitan markets north of Cuicatlan. The railroad line follows the Colonial Camino Real. In all probability, the Camino Real itself followed the old Aztec trade route to Oaxaca via the Cañada, which Cortez, Alvarado, and other Conquistadores used in their movements to Veracruz and the Etla region of Oaxaca. The other major route to Oaxaca, and the one most frequently used, runs through the Mixteca Alta, passing Huajuapan de Leon (Peñafiel 1885). Local Mestizo elites look more to Tehuacan and Puebla than to Oaxaca as their urban centers and keep second homes in these towns. This may have also been the case with the Colonial elite. At least one known *corregidor* of the Cuicatec, Alonso de Buiza, did not live in the area but was a *regidor* of the city of Puebla (*ENE*, VI: 57-59). Apparently this was a common phenomenon in other areas of Mexico. Edward Calnek (pers. commun.) has encountered numerous laws and law suits in the AGN dealing with the resident requirements of officers in relation to their areas of jurisdiction.

Identification of Cuicatec Cacicazgos

The Cuicatec are a good example of the historical stability of communities in highland Mexico (cf. Barlow 1944). The present distribution of Cuicatec-speaking communities is nearly the same as it was at the time of Spanish entry. Since the period between 1544 and 1962, many of the territorial boundaries have remained the same. Major population centers are located in the same relation to each other and to the cardinal points of the compass, and are close to and control the same water courses as in the beginning of the sixteenth century. Moreover, their relative political importance seems to have continued to the present. Ancient cacicazgo territories are preserved in present municipal arrangements. Cacicazgo capitals are today municipal headtowns (*cabeceras).* Some of the subject settlements of the sixteenth century have become independent political units or *municipios* (see discussion below of Sanat María Papalo and Los Reyes Papalo), but most of the old estancias and barrios are today politically dependent (*dependencias*) on the municipal headtowns that were their sixteenth-century cabeceras, or are smaller hamlets and villages (pueblos, parajes, partidos, ranchos, rancherías). Many of the house-sites (including those of all major capitals) have archaeological remains of buildings and pottery for the Classic and Postclassic periods testifying to ancient occupation, and old boundaries seem to have changed little if at all. The major difference in the settlement picture is the appearance of new habitation sites which did not exist in the sixteenth century. These have been mostly in the north, showing the general movement toward the northeast discussed previously. Few have disappeared. Only those sites which existed in the sixteenth century are listed below.

We have been able to locate two-thirds of the population nuclei mentioned in the sixteenth-century sources, which have persisted up until the present. Of over forty Cuicatec settlements which appear to have existed in the first part of the Colonial Period, thirty-five exist today with the same name and are in the same or approximately the same location. Two others have been preliminarily identified, four are doubtful, and only six are unknown today. Identifications of settlements begin on p. 173.

Locating the settlements, a procedure which was facilitated by their historical stability, was based on a variety of information, primarily the names of the communities. Cuicatec communities usually have three names: a native Cuicatec name; a Nahuatl name given by the Mexica conquerors and transcribed by the Spaniards into sixteenth-century Spanish orthography; and a saint's name given by the Spanish-Colonial Church. In the identifications of settlements that follow, alternate spellings found in the sixteenth-century documents are followed by the Cuicatec place names where known (in italic). The spelling of the Cuicatec names has not been phoneticized, but has been left in the orthography of the original documents. Orthographic transformation would have reduced the number of alternative spellings, but, since it is hard to resist changing a letter to approximate a sound, we have preferred to avoid that

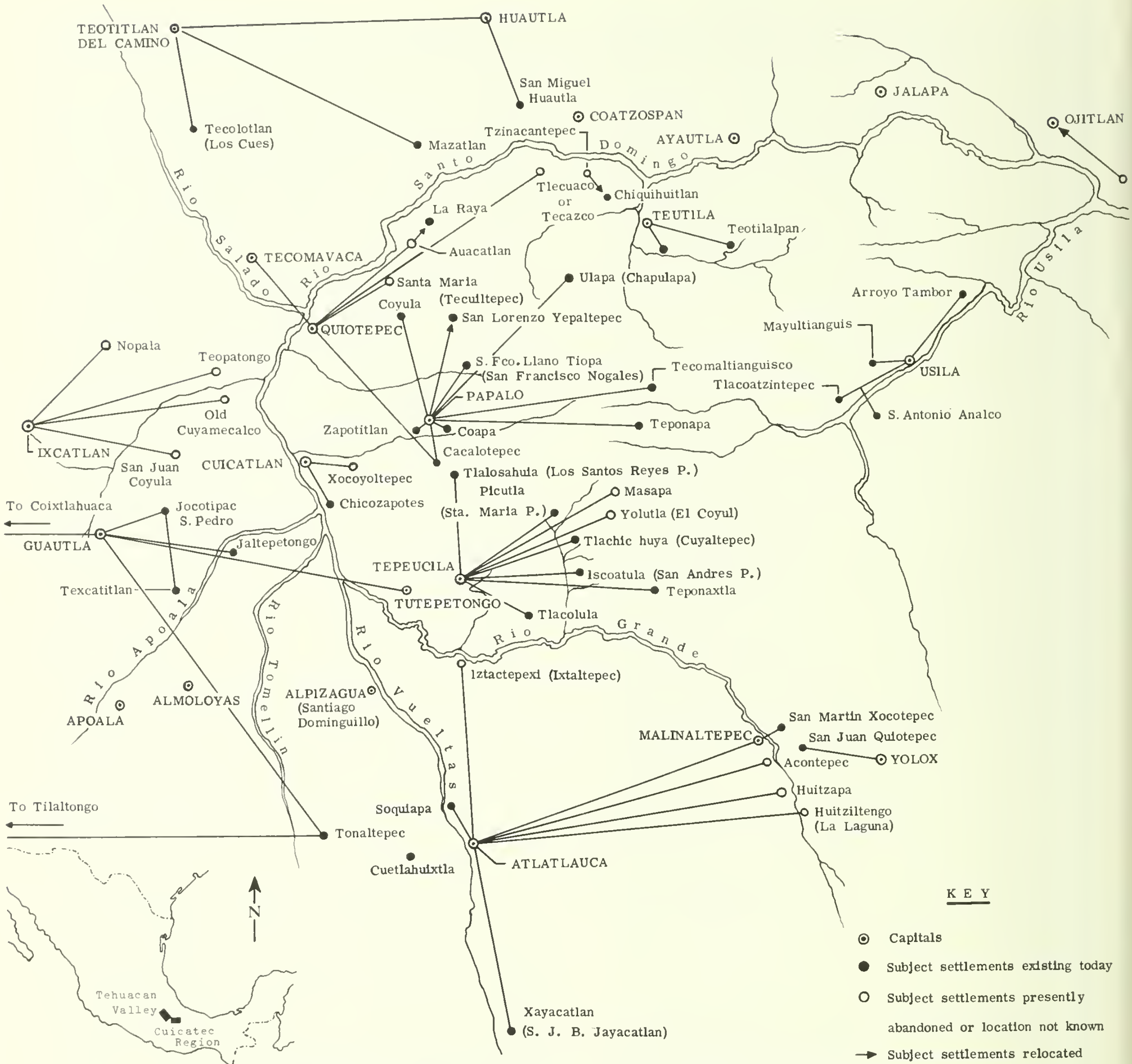


Fig. 75. Map of Cuicatec cacicazgos and some neighbors ca. 1545-1580.

temptation. Anyone interested can easily follow the same paths of discovery that we did.

In a few lucky instances all three names are known to us. This kind of coincidence, however, is rare. Sometimes the Spanish spelling of the Nahuatl name changed, sometimes a local Spanish scribe had difficulty in transcribing a Cuicatec word which had become muddled and incomprehensible. Other times only one or two of the names are given in a particular source. In most cases, those communities that have been thoroughly identified are known to us by at least two of the name combinations. In other cases with rare or unusual names, one has been sufficient.

Two other sources aided in identification: a set of maps, showing locations of contemporary communities with respect to each other; and lists of political jurisdictions, headtowns, and subject settlements for different historical periods. Any settlement, identified as to name, but with either different political attachments or geographical location, was classified as doubtful, unless we knew of a documented explanation for the switch involved. The reverse sometimes was also true. In two cases, Chicozapotes and Chapulapa, the complete names were missing but the locations were known. The writers of the *PNE* had the intuition (so convenient for us) to have listed subject settlements of a corregimiento in order, according to a line of geographical locations. In a few instances such as Atlatlauca, larger jurisdictions seem to have changed. The towns have not been moved; but the district boundarys were changed, usually by the state government for bureaucratic reasons of its own. Such changes are indicated below for each community.

About 1560, all the settlements listed belonged to three *provincias:* Cuicatlan, Papalo-Teutila, and Teotitlan (or Tecomavaca). Today, twenty-six belong to the District of Cuicatlan which includes the old provincias of Cuicatlan and Papalo-Teutila; five belong to the District of Etla which moved its frontier northward, taking part of the old District (and provincia) of Cuicatlan. One, Malinaltepec, belongs to the District of Ixtlan. In this case the frontier did not move; jurisdiction simply changed from a "Cuicatec" district, to a Chinantec municipio across the river, in a "Chinantec" district.

The Cuicatec states, or *señoríos*, were autonomous, political units populated by Cuicatec speakers, territorially bounded by frontiers marked by natural features, or painted boulders. The frontier lines and points of boundary were ravines or minor streams not used for irrigation, or ran from hilltop to hilltop in the small mountain chains. Atlatlauca, Alpizagua, and Cuicatlan were in the semi-arid Cañada, near the major river, the Rio Grande. Three others, Papalo, Tepeucila, and Tutepetongo, occupied higher and colder lands in mountainous regions crossed by minor rivers. Each state controlled its clearly marked territory and the water sources for irrigation within it and each had one major nuclear settlement, or cabecera, in which the governing classes resided. Within the territory of the state, or *cacicazgo* (derived from the Spanish title *cacique* given to the local overlords), other smaller outlying hamlets which were politically dependent (*sujetos*) were located near the cultivated lands, especially in spots where minor streams made irrigation possible.

The terms *sujeto, estancia, pueblo, parcialidad,* or *barrio* are ambiguous, not only for the Cuicatec but for all Mesoamerica as well (Hunt and Nash 1967). In general, as the terms were applied by the Spaniards in the Cuicatec, the barrios were usually larger territorial units than estancias. But sometimes the political status of an estancia was greater than that of a barrio and upon occasion the two words are used as synonyms. Only by describing each case can we determine the real status of these settlements. Thus, a situation similar to that described by Gibson for the Valley of Mexico obtained here (1964: chap. III). Both *barrios menores* and estancias seem to have been dependent upon the state's capitals in a line of tribute both locally within the cacicazgo and as a collection chain for the Aztecs and the Spaniards after them (1) (cf. Notes, p. 258).

The political status of subject settlements was unstable. It is probable that, among the Cuicatec, estancias were subject to cabeceras *only* because they were population off-shoots. The Cuicatec states were small and politically defensive and dependent estancias were usually not acquired by conquest as they were among other groups in Mesoamerica. The political status of a new settlement, that is, whether it remained dependent or became a semi-independent political sub-unit of the state capital, may have been influenced by population growth, wealth, and the ambition of local political figures.

San Lorenzo Yepaltepec, an estancia of Papalo, was founded ca. 1172-1198 by colonists from Cacalotepec, another estancia of Papalo; and, in 1562 and for the three preceding generations of rulers, it had been attempting to separate from its mother settlement, Cacalotepec. These colonists had been relocated en masse by the overlord of the cacicazgo to protect the northern frontier, following the warlike attempts of Quiotepec to encroach on Papalo's irrigable lands by introducing settlers (2). Because of its connection with "water wars," (see discussion below), this individual instance of a resettled population before the Spanish policy of *reducciones* may cause us to reconsider Armillas's view, derived from other published native chronicles (1964: 323), that such movements were not important. Furthermore, population pressures such as this have to be understood, not on the basis of numbers, but on the basis of ratios of cultivator to available improved irrigated lands. Although the two estancias each had their own local ruler, for tax purposes at the time of the first Spanish *tasación* (written regulations on tribute) they were united in a chain, Yepaltepec-Cacalotepec-Papalo (*barrio mayor*)-Spaniards (IPCCS: 97 passim).

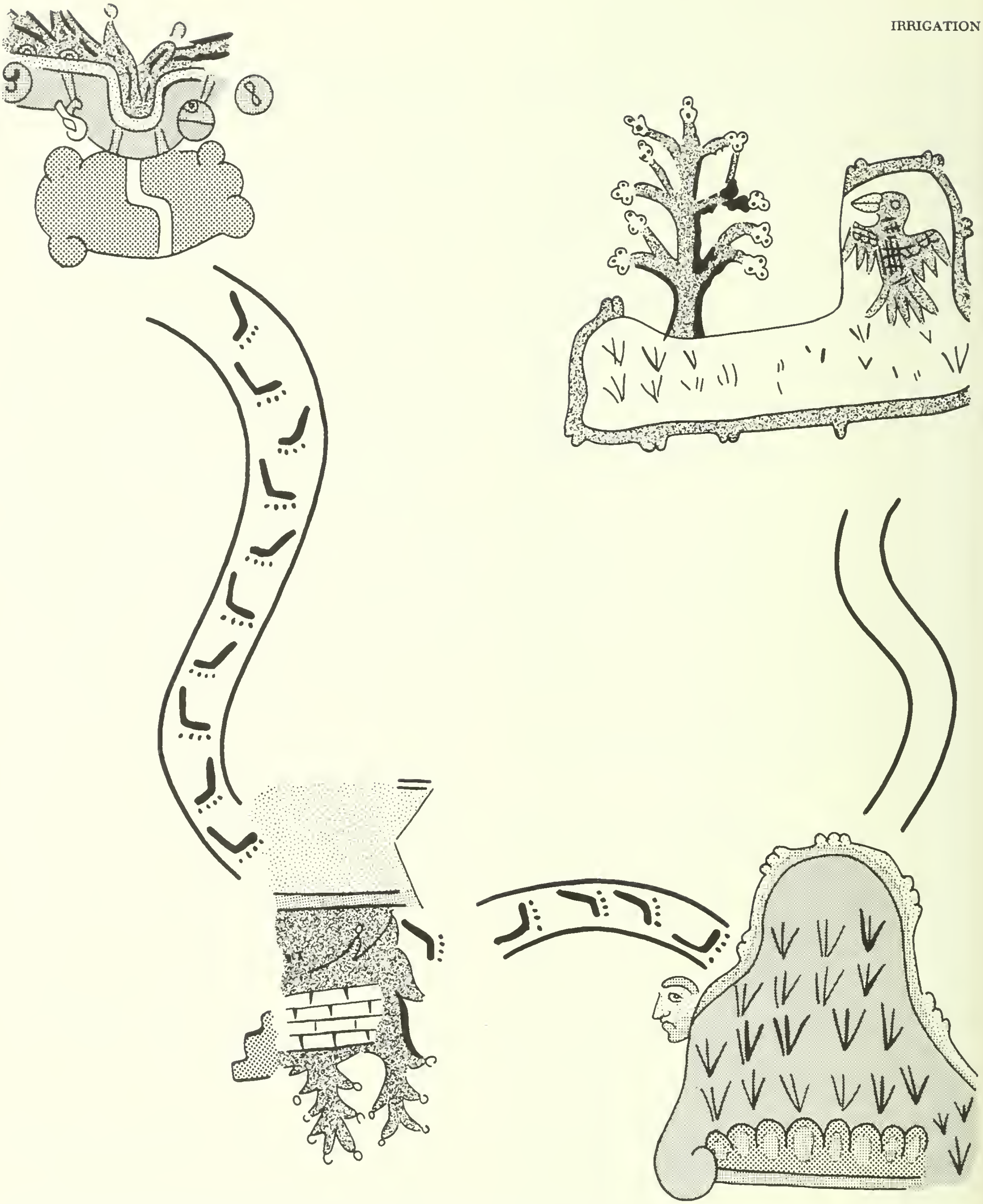


Fig. 76. Glyphs of Cuicatec towns. Left to right: Atlatlauca, the water made red (by red earth?); unknown town (this glyph also appears in the Codex of Yanhuitlan); Jayacatlan, land of masks; Tutepetongo, hill or land of birds. Fernandez Leal Codex, Lámina VIII Reverso.

The process of internal migration, colonization, and later political fission or "schismogenesis," (cf. Bateson 1958) seems to have been endemic until the time of the Conquest (cf. Gibson 1964 for an equivalent situation in the Valley of Mexico). However, a counter tendency towards the unification of settlements into larger cacicazgos was also at play. Both processes were arrested, first by the Aztecs and later by the Spaniards, both of whom created out of the unstable local territorial groups, stable administrative units in which the interrupted stage of political process became frozen as the status quo, at least for the time being (*PNE*, IV: 90, 96, 169, 186).

Within cacicazgos, subject settlements and cabeceras each had clearly defined boundaries, and were ruled separately. Each had its own agricultural fields, its own sources of water, and its own local administrators(*nyandi* or *tequitlatos*) who were responsible to the rulers.

In the relaciones only one cacique for each cacicazgo is mentioned, but in the AGN documents it appears that several contemporaneous men had the title. Clearly all rulers of estancias were classified by the Spainards as caciques and all received the title *tecuhtli* attached to their names (see discussion on genealogies of caciques below and in the Appendix).

In Papalo, however, not every estancia had its own cacique. Several estancias were tied under one political head, and these local lords were themselves subordinate to the overlord of the cacicazgo.

The territorial political separation of the village-states did not indicate separation on other cultural counts. Dialectical divergency within Cuicatec, although it follows the boundaries of old political units, appears from gloto-chronology to date only approximately from the time of Spanish conquest (Holland 1959). Linguistic evidence of political-cultural distinctiveness, however, appears between Cuicatec-Mixtec and Mazatec. Holland attributes the linguistic features to degrees of geographical rather than purely social isolation.

Four major Cuicatec headtowns of the sixteenth century, Atlatlauca, Cuicatlan, Papalo, and Tepeucila are still cabeceras. Two others which appear to have been small villages even then, are now dependencies, Tutepetongo and Alpizaqua (Dominguillo).

Capitals and Subject Settlements

The most important population nucleus in the south was Atlatlauca, located in the southernmost section of the canyon (Fig. 75). Atlatlauca's headtown was in a small, enclosed valley, in the Vueltas river basin, between the narrow canyon walls where two mountain streams descend into this valley (*PNE*, IV; *ENE*, IV: 130-448). Today Atlatlauca is primarily a Mestizo municipio, in the Ex-Distrito of Etla, but is said to have a few Chinantec (and Zapotec?) speakers. We did not carry on field work in this community, except for interviewing informants from the region, in Cuicatlan. We took, however, a low flight in a small plane, to determine the location, settlement pattern and land use of the present town from a bird's eye view, and check it against local maps prepared by the Papaloapan Commission workers. In the later part of the sixteenth century Atlatlauca became partially incorporated into an encomienda granted to a local corregidor (R. de O. 1904: 84). Before Spanish entry Atlatlauca was a powerful señorío or small state, here referred to as a cacicazgo. This Cuicatec outpost was surrounded on three sides by Mixtec, Zapotec, and Chinantec settlements. In fact, one secondary source erroneously lists Atlatlauca as Chinantec (Herrera 1726: 174). One community of the Chinantec language group, Malinaltepec, maintained cordial relations with Atlatlauca but carried on warfare with the Chinantec of Yolox (Fig. 75) (*PNE*, I: 50; IV: 163-176). Atlatlauca had at least six pueblos or barrios (*PNE*, IV: 163). Some of these apparently had their own subject hamlets, so that in the *PNE* (I) thirteen, rather than six, appear listed. Only the larger subjects mentioned in the *PNE* (IV) appear in contemporary maps, censuses, and other similar sources. The hamlets which were "subjects of subjects" appear to have been extremely small clusters of huts with a few households (*PNE*, I: 50). The writer of the description in the *Suma de Visitas* said that there were twelve, but then proceeds to list thirteen, besides the headtown. Location and reconstruction of dependent settlements of the Atlatlauca headtown is facilitated by a sixteenth-century map (*PNE*, IV: 163). On contemporary maps the cabecera and three of the subjects are in identical locations to those on the sixteenth-century map; one other is dubious. The single anomaly seems to have been relocated a few (three?) kilometers west of the original spot. The Cuicatec of Atlatlauca, surrounded by inhospitable, semi-arid mountainous chains, controlled the only irrigable lands in the immediate region. Their dependent or subject towns were all located in the territory immediately adjacent to the canyon. Six of these had irrigation (*PNE*, I: 50). Settlements below are arranged geographically following Fig. 75; capitals or headtowns are followed by their clustered subject settlements. The changes in political status and the contemporary situation of each settlement follow the names and tentative translations in Nahuatl and Cuicatec.

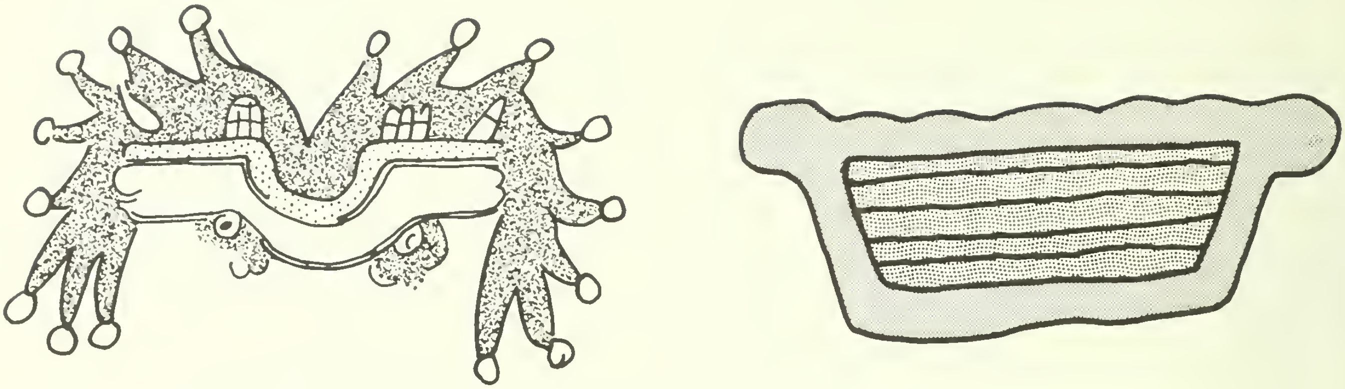


Fig. 77. Glyphs of Atlatlauca. Codex Porfirio Diaz Lámina G (left) and Mendocino Codex, p. 25. Note how the Mendocino presents highly stylized and simplified glyphs for what in earlier pictorial manuscripts appear as elaborate symbolic statements.

Atlatlauca, Atlanca, *ayancua.*
Nahuatl: red water (or narrow water).
Cuicatec: river between the narrows; river in a canyon.
Changes in political status: headtown of cacicazgo; headtown of corregimiento-encomienda; pueblo-headtown of Jurisdiccion de Doctrina; municipio, Ex-Distrito of Etla.
Contemporary: San Juan Bautista Atlatlauca. Municipio of the Ex-Distrito of Etla.

Iztactepexi, Iztaquetepeque.
Nahuatl: white hill or hill of salt.
Pueblo subject of Atlatlauca; headtown with Governor, subject to the Doctrina of Yanhuitlan. Municipalidad, Ex-Distrito of Etla.
Contemporary: Ixtaltepec. Town of the Ex-Distrito of Etla. If the contemporary town is a counterpart of that in the sixteenth century, it was relocated from a position north to one west of Atlatlauca.

Acontepeque, Acunlepeque.
Nahuatl: hill of ?
Pueblo subject of Atlatlauca.
Contemporary: Acontepec (?). One of the small settlements near Malinaltepec today. Identification is doubtful.

Huitzapa, Ysapa.
Nahuatl: water of the hummingbirds.
Town subject of Atlatlauca.
Contemporary: unknown.

Huitziltengo, Chilchiltengo.
Nahuatl: place of hummingbirds.
Pueblo subject of Atlatlauca.
Contemporary: this may be the small settlement of La Laguna(?).

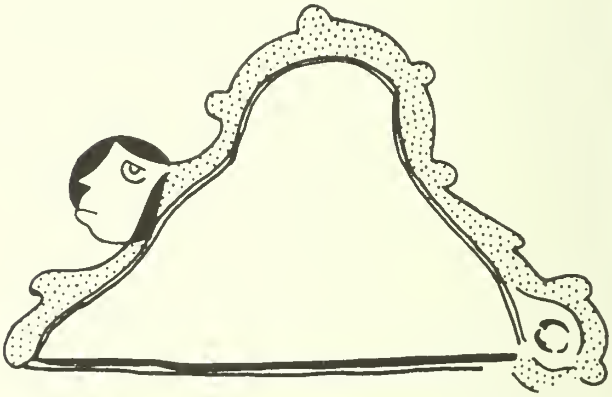


Fig. 78. Glyph of Xayacatlan. Codex Porfirio Diaz, Lámina G.

Xayacatlan, Cacapetlan.
Nahuatl: land of masks.
Pueblo subject of Atlatlauca.
Contemporary: San Juan Bautista Jayacatlan. Town of the Ex-Distrito of Etla, southeast of Atlatlauca.

Soquiapa, Zoquiapa, Soquiapan, Soquiapam, Coquiapa.
Nahuatl: on the muddy waters, or the swampy river.
This town was located adjacent to Atlatlauca, and it may have been a subject by conquest in the wars against the Zapotec town of Tecuicuilco. Apparently after the Spanish Conquest it reverted to the jurisdiction of Tecuicuilco, which may indicate that it was

populated by Zapotecs, not Cuicatecs. Later it returned to Atlatlauca, as agencia municipal, i.e., without independent political representation.
Changes in political status: pueblo subject of Atlatlauca; República de Indios with Governor, attached to the jurisdiction of Tecuicuilco; town of the Ex-Distrito of Etla; town, Ex-Distrito of Cuicatlan (?), still attached to Atlatlauca.
Contemporary: Soquiapan. Municipio of Atlatlauca, Ex-Distrito of Etla.

Malinaltepec, *Malama* (Chinantec).
Nahuatl: crooked hill; hill of reeds or grass.
Chinantec: crooked hills.
Chinantec cacicazgo, allied to the Cuicatec cacicazgo of Atlatlauca.
Contemporary: Malinaltepec. Rancho of the municipio of San Juan Quiotepec, Ex-Distrito of Ixtlan. After Spanish entry, this Chinantec ally of the Cuicatecs fell back into the hands of the powerful cacicazgo of Yolox, to which San Juan Quiotepec was allied, and with which Malinaltepec had fought wars. Its present political dependency as well as its decay into a minor hamlet, probably dates from the period of disintegration of the Atlatlauca state after Spanish entry.

San Martin Xocotepec.
Nahuatl: hill of *jocotes* (a type of native cherry).
Hamlet subject of the cacicazgo of Malinaltepec across the river, on the Chinantec side.
Contemporary: rancho of San Martin.

Cuetlahuixtla, Cotahuixtla.
Nahuatl: place where the snakes go (?)
Town located in the boundary of the cacicazgo of Atlatlauca. Pueblo Indio with Governor, Jurisdiction of Cuicatlan, dependent through Atlatlauca; agencia municipal of the municipio of Nacaltepec, Ex-Distrito of Cuicatlan.
Contemporary: San Francisco Cotahuixtla. Rancho-agencia municipal of the Municipio of Santiago Nacaltepec, Ex-Distrito of Cuicatlan.

To the north, on the boundary between the cacicazgos of Atlatlauca and Cuicatlan, was the cacicazgo-town of Alpizagua (today, Santiago Dominguillo), with its own small stream, in a narrow passage of the Rio Grande canyon. Alpizagua is mentioned by the relaciones and by Ponce (1873: 269) and had irrigation. Except for the mention in Martinez Gracida (1883) that it had been founded in the fifteenth century by a cacique named Don Domingo de Fonseca (*sic*), nothing further is known at present (*Suma de Visitas*: 164; *PNE*, IV: 164; Ponce 1873; 269). Unless future research provides us with usable information on Alpizagua, it must remain an unfortunate blank.

Alpizagua, Alpisagua, Dominguillo, Santiago Dominguillo, *hiconguey* (?).
Nahuatl: unknown.
Cuicatec: thin river, or narrow river.
Pueblo with Governor, Doctrina of Cuicatlan; agencia municipal, municipio of Cuicatlan.
Contemporary: Santiago Dominguillo (*hikon guey*). Agencia municipal, ranchería of the municipio of Cuicatlan, Ex-Distrito of Cuicatlan.

Besides Alpizagua, two other cacicazgos existing today as small towns within the district of Cuicatlan are mentioned in the sources; these also are not sufficiently documented. Tutepetongo (or Tututepetongo) and Tonaltepec were subjects of the Mixtec town of Guautla (Bernal 1962). Like Alpizagua, both had irrigation. Tonaltepec had been ruled by Mixtecs from Tilaltongo (Bernal 1962) in pre-Hispanic times. Tutepetongo had a regular market (*tianguis*) in 1562 (IPCCS: 55). Tutepetongo, moreover, is with a high degree of probability the mysterious "Tututepec" which appears in the Codex Mendocino with Ojitlan and Chinantla (see Berlin 1947: 18-20). The difficulty of locating it was probably related to the fact that it seldom appears on printed maps.

Tutepetongo, Tututepetongo, Totoltepetongo, *Hillado, Yada.*
Nahuatl: land of birds.
Cuicatec: bird hill.
Changes in political status: headtown (?) of a cacicazgo subject of Guautla (Mixtec Huautla, Oaxaca), a market center; agencia de Cuicatlan; rancho-pueblo of the municipio of Cuicatlan.
Contemporary: San Francisco Tutepetongo or *'i?yada.* Agencia municipal of Cuicatlan.

North of Dominquillo, where the Cañada opens out into a flat relatively wide valley, was the cacicazgo of Cuicatlan (*PNE*, IV; *ENE*, IV: 130-148). Here the canyon valley averages approximately 3 to 4 kms. in width, and is 20 kms. long, running in a south to north direction and descending from 600 to 500 meters above sea level. Two mountain streams (both called Chiquito) are located in the northern and southern parts of the municipio of Cuicatlan. Since Colonial times at least they have been controlled for irrigation by the settlement of Cuicatlan. Cuicatlan shared a border to the west with Mixtec groups, subjects of Yanhuitlan and Coixtlahuaca, located above the canyon in the Mixteca Alta (Bernal 1962; Jiménez Moreno and Higuera 1940; Burgoa 1674). To the north the Cuicatec shared a border with the cacicazgo of Quiotepec (discussed below). To the east Cuicatlan reached the lands of the Cuicatec states located in the mountainous flanks of the Llano Español (*PNE*, I: 101; IV: 183-189; R. de O.: 68). The town of Cuicatlan today is the headtown of both the Mestizo municipio of the same name, and of the Ex-Distrito, and is the most important commercial, administrative, and political center of the region. Early in Colonial times, the first part of the sixteenth century, the Spaniards established there a corregimiento, and two sugar haciendas and mills (*ENE*, VI: 57-59; IX: 43-49; XIII: 3-46; Martinez Gracida 1883; Esteva 1913). A concentration of Spanish authority was promptly felt, which probably expanded the importance of the earlier cacicazgo town. Along with Atlatlauca, Cuicatlan seems to have been one of the two largest and wealthiest Cuicatec town-states before Spanish arrival. Apparently Cuicatlan was never assigned as an encomienda but always remained under royal control (*ENE, loc. cit.*).

Cuicatlan was centralized; it had no subject settlements. An abandoned settlement up river from Cuicatlan may have been the hamlet of Xocoyoltepec, which has since disappeared. The *Suma de Visitas* indicates four barrios for Cuicatlan. These were probably internal divisions of the cabecera settlement and may have been centered around four major elevations of the terrain. These four major elevations are the areas in which most abundant surface remains and pottery refuse can be found, and today are marked by crosses. Two of these are part of today's town's barrios with their own names. One is part of the *centro* of Cuicatlan, and the fourth, slightly separated from the headtown by a neutral ground of orchards, is called a barrio, but politically is an agencia municipal incorporated into the township lands (*PNE*, I: 101). This cluster of house-sites, Chicozapotes, mentioned in the *Suma de Visitas,* is today a separate barrio named San Pedro Chicozapotes in the municipio of Cuicatlan. This barrio was located on the southern stream, while the capital was on the northern stream, covering a distance of 3 kms.

Cuicatlan. *Ya(ba)haku; Guetrabanco (sic), kaata-bahku* (?).

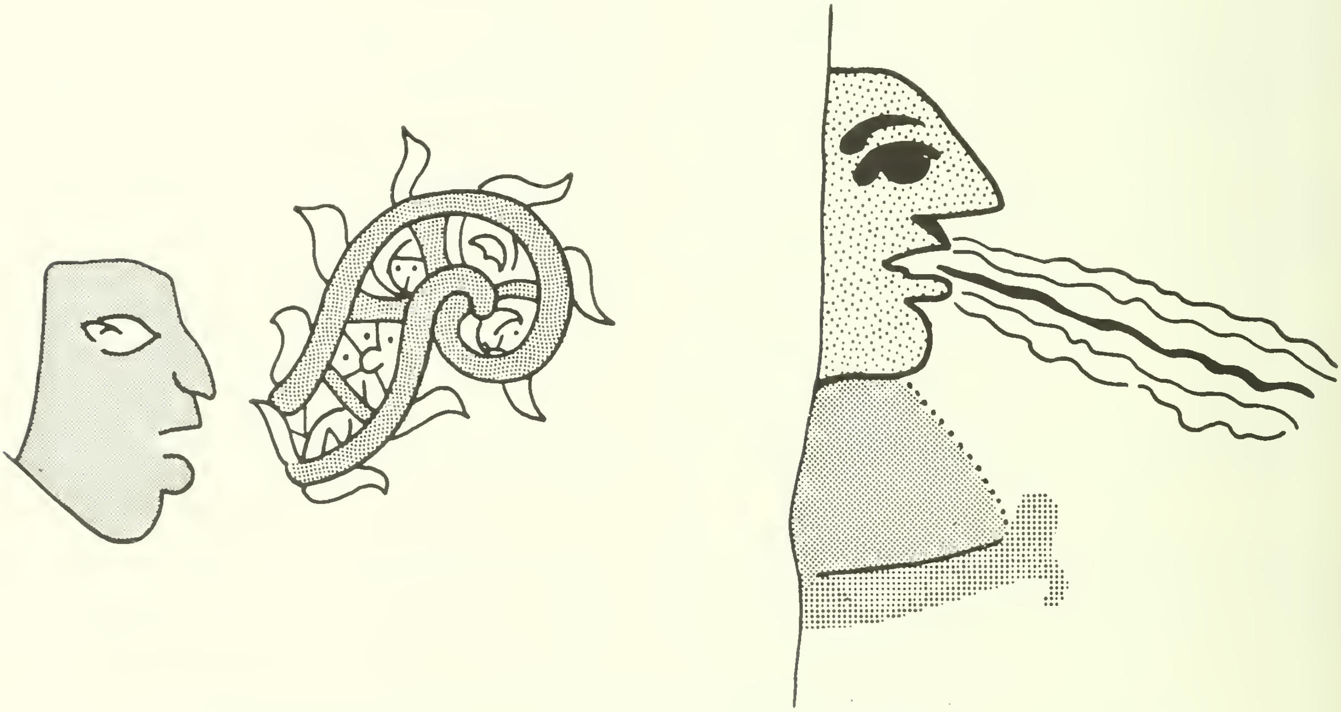


Fig. 79. Glyphs of Cuicatlan. Mendocino Codex, p. 43 (left) and Codex Baranda, Lámina I.

Nahuatl: land of song or singers.
Cuicatec: place of houses, and/or hill of song; house of song.
Changes in political status: cabecera de cacicazgo; cabecera de corregimiento; cabecera de República de Indios; agregado de Teotitlan; cabecera de municipio and distrito.
Contemporary: San Juan Bautista Cuicatlan. Municipal headtown. Ex-Distrito de Cuicatlan, Oaxaca.

Xocoyoltepec, *Yloyaha.*
Nahuatl: hill of sorrels.
Cuicatec: unknown.
Hamlet of Cuicatlan in the highland section of the cacicazgo territory. It was not a subject, but a separate housing nucleus politically incorporated into the capital.
Contemporary: archaeological site, abandoned housesite above Cuicatlan, on the road to Reyes Papalo. A legend in Cuicatlan today affirms that the population abandoned the site and joined the headtown after the Spanish Conquest (*PNE*, IV: 183).

Chicozapotl (?).
Separate housing nucleus of the capital of Cuicatlan. It was not a subject but politically an integral part of the capital.
Contemporary: San Pedro Chicozapotes. Barrio of the town of Cuicatlan, municipio of the same name. Separated from the headtown by approximately 3 kms., it controls the southern stream of the municipio's headtown and has adjacent agricultural fields. Local legends testify that the Indians moved to this section when the Spaniards took over the headtown. Today it has the political status of agencia municipal. Locally it is called a barrio. With three other unnamed barrios listed in the *Suma de Visitas*, they are today's divisions of the town of Cuicatlan itself: cerro Galeana, cerro de las Cruces, cerro Zopilote, and Chicozapotes.

Two other major cacicazgos, in terms of territorial expansion, were located in the mountainous flanks east of Cuicatlan: Papalo and Tepeucila (*PNE*, I: 186, 287-288; IV: 88-99; R. de O.: 68; *ENE*, IV: 147). Another small one, Tutepetongo, was also in the mountains (Bernal 1962), but was subject to the Mixtec. Papalo and Tepeucila remained Indian Republics, attached to an *alcaldía mayor* (Teutila). Until the beginning of the seventeenth century Papalo was assigned as encomienda but Tepeucila remained in the *Real Corona* (*ENE*, IV: 122-139, 70-101; Icaza 1925: 5-6; R. de O.: 83). The territory of these two major mountain states consisted primarily of land planted with seasonal rain crops. Irrigation was possible only in the alluvial soil bordering three small streams affluent to the Rio Grande which the cacicazgo of Papalo embraced in its territory. That is, the people of Papalo used the infield-outfield system described by Eric Wolf (1966: 2). Population sizes of the mountain towns were smaller than in the canyon cacicazgos, and in general the mountain towns seem to have been poorer. Both Papalo and Tepeucila are today headtowns of large Indian municipios. East of them was Chinantec country (*PNE*, IV: 45-62; R. de O.: 67-68; Espinosa 1910 [1934 ed.]).

Papalo had a major settlement (3) (barrio mayor; *Tecpa*: "where the lord lives"), its cabecera, and three barrios, plus at least seven minor estancias (*PNE*, IV: 89; IPCCS passim). All but one exist today. Tepeucila had a cabecera and eight subject settlements, several of which, at the time the relaciones were written, had been decimated by epidemics (*PNE*, IV: 94-95). All but two exist today.

Four municipios of today emerged from sixteenth-century subject settlements of Papalo and Tepeucila: Chapulapa (Ulapa), Tlalixtac, Santa María Papalo, and Los Reyes Papalo. All of these formed, by expansion and separation, some of the subject settlements in the frontier of the Papalo and Tepeucila states. Tlalixtac, originally a hamlet of Chapulapa, split off in 1711 and moved into a population vacuum in the northeast border. Santa María emerged out of the most remote and isolated of the Cuicatec subjects, on the Chinantec side of the mountain range. Los Reyes came out of a single settlement nucleus, probably for political rather than geographic or economic reasons. Otherwise, political attachments have remained the same, with the contention that municipal political units and names (municipios, ranchos, barrios and rancherías, and agencias municipales) have replaced the old state names (estancias, sujetos, and cabeceras).

Papalo, Papalotiquipaque, Papalotepec, Papalotiepa, Papalo/Tecpa, Papaloticpac, *duno* or *duvoo.*
Nahuatl: place or hill of butterflies; place of the butterfly inside; butterfly house of the lord.
Cuicatec: butterfly.
Changes in political status: headtown of cacicazgo; headtown of República de Indios, with Governor; headtown of Indian pueblo; part of the alcaldía mayor of Teutila; headtown of corregimiento; headtown aggregated to Teotitlan; headtown of municipio.

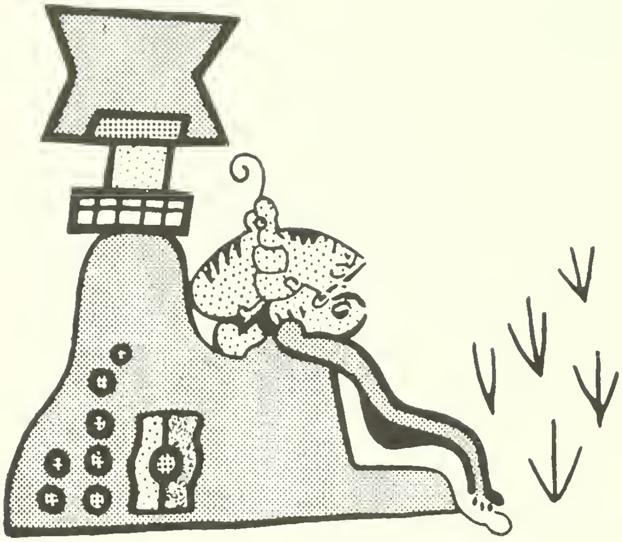


Fig. 80. Glyph of Papalotecpan. Codex Porfirio Diaz. Lámina N. The glyph is composed of the *calli* (house) symbol for *tecpan*, government house or palace, over the hill, a butterfly (*Papalotl*), and a water spring emerging from the butterfly's body at the tail end.

Contemporary: Concepción Papalo. Headtown of municipio of the same name. It is the largest of the Papalo towns and still controls most of the pre-Hispanic settlements under its jurisdiction.

Coyula, Cullulapa, Coyulapa, Culleilapam, *Hico Guiya, yeninguiya, 'ingwiya,' Ywiya.*
Nahuatl: ringing waters (water which makes noise like jingle bells).
Cuicatec: unknown.
Changes in political status: estancia of the cacicazgo of Papalo; pueblo of Cuicatlan, with own *gobierno*: municipalidad de Cuicatlan, ranchería.
Contemporary: San Juan Coyula. Agencia municipal, rancho of the municipio of Cuicatlan.

San Lorenzo Yepaltepec, Yepatepeque. *katahiche, ka't'icha*; *yanyata.*
Nahuatl: before the hill.
Cuicatec: unknown.
Changes in political status: estancia of the cacicazgo of Papalo; pueblo of Papalo; municipalidad incorporated to Papalo; ranchería-agencia municipal of Concepción Papalo.
Contemporary: San Lorenzo Papalo (*Ka'ti'cha*). Dependency, municipal agency of the municipio of Concepión Papalo.

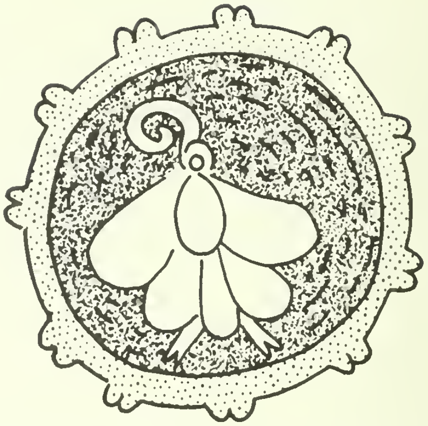


Fig. 81. Glyph of Papalo. Fernandez Leal Codex, Lámina V Recto. The name glyph of the capital town of the state of Papalo (land of the butterfly) appears in a water field surrounded by the symbol for earth or hill. A contemporary legend in Papalo claims that, in mythical times, a large lake or lagoon was located in a hill above the present-day town, behind the abundant archaeological remains. The lagoon was "emptied by the Gods" when they became angered by the people's sins (after the Spanish Conquest) and poured all the water into the eastern side of the Cuicatec district. This myth probably can serve as an ethnogeographic "explanation" in that it describes Papalo as located in the rain shadow of the mountain range, with less water than the eastern towns in the tropical lowland sector of the District. The myth may also have been based on historical fact: Papalo may have had a man-made lagoon or reservoir of a dam abandoned after the Spanish Conquest. If this is the case, a simple archaeological survey should be enough to check against the mythical suggestion. Other towns in the Mixtec highlands have very similar legends, suggesting, as do the Codex materials, that man-made irrigation works were extensively used in this area of Mesoamerica before Colonial times, and abandoned some time during the sixteenth or seventeenth centuries. We discuss in the text the possible causes of this technological shift.

San Francisco Llano Tiopa, San Fco. Llano Verde, Xoxotepeque, San Fco. Nogales, *lukuey, koaney, ku kue; tao llako llanguey* (?).
Spanish: plain; green plain.
Nahuatl: green hill, green plain.
Cuicatec: green plain; field; green snake.
Changes in political status: estancia of the cacicazgo of Papalo; estancia of the corregimiento of Papalo;

rancho-barrio of Papalo; municipal agency of Concepción Papalo.
Contemporary: San Francisco Nogales (*ku kwe*). Rancho of the municipio of Concepción Papalo.

Ulapa, Vlapa, *nanama.*
Nahuatl: unknown.
Cuicatec: unknown.
Estancia of the corregimiento of Papalo.
Contemporary: possibly Chapulapa (*diaka*). Municipio, Ex-Distrito of Cuicatlan. The village, whose land grants date from 1606, has long historical roots. It is located in the only flat enclosed valley in the intermontane region where irrigation is possible. In the *PNE* the estancias of Papalo are listed in geographical order, in an arc from northwest to southwest. According to that listing, Chapulapa, whose name seems to be a longer version of Ulapa, is the only Cuicatec community today in the location of Ulapa. The Cuicatec name, however, either has changed since the sixteenth century, or was an alternate to the present-day name. According to Martinez Gracida (1883), it was "founded in 1500," a good indication that it is a pre-Hispanic settlement! Identification of the pre-Hispanic estancia remains inconclusive until further research is done in local archives.

Tecomaltianguisco, Tecomaltianguise, Tecpantianguise, Comaltianguisco, Comaltianguysco. *loo do che ebe*; *condodoyaza*; *baku 'il'e.*
Nahuatl: market of gourds.
Cuicatec: ? house of (?); on the other side of *cheve* or mountain (?).
Changes in political status: barrio of the cacicazgo of Papalo; barrio of the municipio of Papalo.
Contemporary: Tecomaltianguisco. Barrio-agencia municipal of the municipio of Concepción Papalo.

Teponapa, Tupanapa, Tecpanapa, Tepanapa, Teponapa, *lla lla ma, ninoma, lla yama lladuchi, nune moo.*
Nahuatl: land of the house of the lord (?).
Cuicatec: fire gorge; water of fire (?).
Changes in political status: estancia of the cacicazgo of Papalo; estancia of the corregimiento of Papalo; rancho of the municipio of Santa María Papalo.
Contemporary: Teponapa (*nune moo*). Rancho. Municipal agency of the municipio of Santa María Papalo.

Coapa, Coapam, Guapa, *yangua, ingwo.*
Nahautl: land of snakes; in the water of snakes.
Cuicatec: ? water of (?).
Changes in political status: barrio, estancia of Papalo; ranchería of Papalo.
Contemporary: Coapam de Guerrero (*ingwo*). Barrio–agencia municipal of the municipio of Concepción Papalo.

Cacalotepec.
Nahuatl: hill of crows.
Changes in political status: estancia of the cacicazgo of Papalo; San Pedro-barrio of Los Santos Reyes, of the pueblo of Papalo; rancho of the municipio of Los Reyes Papalo.
Contemporary: Cacalotepec. Rancho of the municipio of Los Reyes Papalo.

Zapotitlan, *llaykoteko, itako.*
Nahuatl: land of zapotl.
Cuicatec: the foot of the hill.
An adjacent barrio of Papalo, it is located below the hill which edges the central plaza. It was not a subject but was politically incorporated into the capital.
Contemporary: Zapotitlan. Barrio of Concepción Papalo.

Piedra Blanca, *tao yako, Ya tiako.*
Spanish: white boulder.
Cuicatec: white boulder.
Paraje of the cacicazgo of Papalo, origin of a river, at the time uninhabited.
Contemporary: Peña Blanca. Ranchería municipal, municipio Concepción Papalo.

Huiztepec.
Nahuatl: hill of hummingbirds.
Contemporary: unknown. It does not appear in the *PNE*, but only in the IPCCS. It is possible that it had disappeared as a settlement, or merged, after 1562 and before 1580.

Tepeucila, tepeusila, Tepiuzila, Tepeuzila. *cocaa, hico cucan, cuco*; *yani demel, yantindo, ya'tindu.*
Nahuatl: land of hummingbirds.
Cuicatec, *cocaa-cuco* series: Black Volcano, or "in the edge of the Black Volcano" (the highest peak above the village which in fact is *not* a volcano); *ya'tindu* series: land of hummingbirds.
Changes in political status: headtown of the cacicazgo

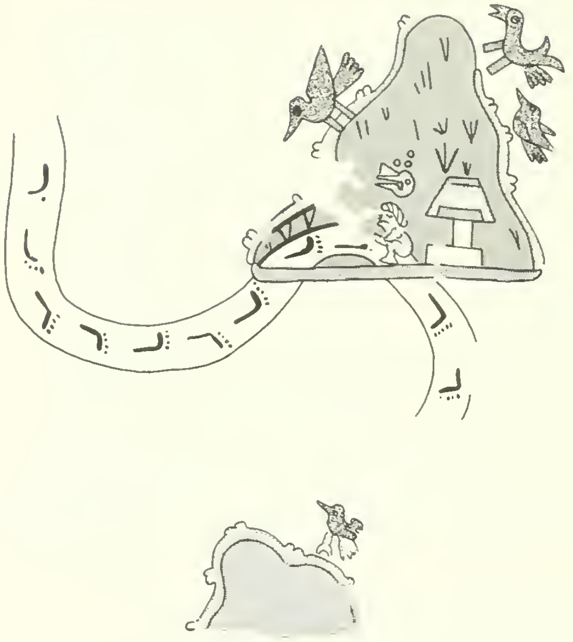


Fig. 83. Glyphs of Tepeucila (land of hummingbirds). Codex Fernandez Leal, Lámina X Reverso (top) and Porfirio Diaz Codex, Lámina F.

of Tepeucila; headtown of the corregimiento of Tepeucila, attached to the alcaldía mayor of Teutila; pueblo de Indios with Governor; pueblo of the corregimiento of Papalo; municipalidad; headtown of the municipio of same name.

Contemporary: Tepeucila. Headtown of the municipio of the same name.

Los Reyes. *Tlalosahuia; diniamy, daname, duname.*
Nahuatl: unknown.
Cuicatec: unknown.
Changes in political status: estancia of the cacicazgo of Tepeucila; pueblo de Indios subject to the partido of Papalo (Los Santos Reyes); pueblo (barrio) of Papalo (Los Tres Reyes); Municipalidad (Los Reyes Papalo); Municipal headtown of the municipio of the same name (Los Santos Reyes Papalo).
Contemporary: Los Santos Reyes Papalo (*duname*). Municipio headtown. It has no dependencies or rancherías, but has several dispersed hamlets, including Cacalotepec. Its name, Los Santos Reyes, was apparently chosen because there were three major temple gods of the settlement in pre-Hispanic times rather than one (see below p. 207). This is one of the free municipios which emerged as a separate political entity from the Papalo-Tepeucila states. The causes of its internal fission are not known, but probably could be related to the original 1562 court cases in which the local cacique, who was of a branch collateral to those of Tepeucila and Papalo, lost his political rights to the other estancias. Its new intrusive character is geographically explicit, since the territory is a very small enclave between the old boundaries of Papalo and Tepeucila. Territorial rights to part of these lands were obtained through a court case against Papalo in 1709-1716.

Picutla. *toyohuy, ty' ule; tiuvi; dabaku.*
Nahuatl: place of the water-squash (?).
Cuicatec, *tiuvi* series: unknown; *dabaku* series: place of houses (town).
Changes in political status: estancia of the corregimiento of Tepeucila; Santa María barrio of Tepeucila; Santa María pueblo of Papalo; Santa María Papalo, municipalidad; headtown of the municipio of Santa María Papalo.
Contemporary: Santa Maria Papalo (*tiuvi, ty'ule*). Municipio headtown. It is one of the major municipios which emerged as an independent political unit (with Los Santos Reyes) from the original territories of the states of Papalo and Tepeucila. The causes of the political-territorial fission are not known. Santa María, however, formed on the eastern boundaries of the Papalo-Tepeucila states, separated from the old headtowns by the highest mountains in the district around the Llano Español. Its territorial insulation may have fostered political independence after the original cacicazgos disintegrated. Political separation must have occurred after 1778, since it was incorporated into Papalo at that time.

Masapa, *tocay.*
Nahuatl: land of deer.
Cuicatec: unknown.
Contemporary: unknown.

Yolutla, *yuzo yangato* (?).
Nahuatl: land of (?).
Cuicatec: unknown.
Estancia of Tepeucila.
Contemporary: this settlement may be the rancho of Tepeucila, El Coyul, or *yuduyanuiya.* Identification is doubtful.

Tlachic huya, *Yanduche, yanin.*
Nahuatl: unknown.
Cuicatec: thorn (?).
Changes in political status: estancia of the corregi-

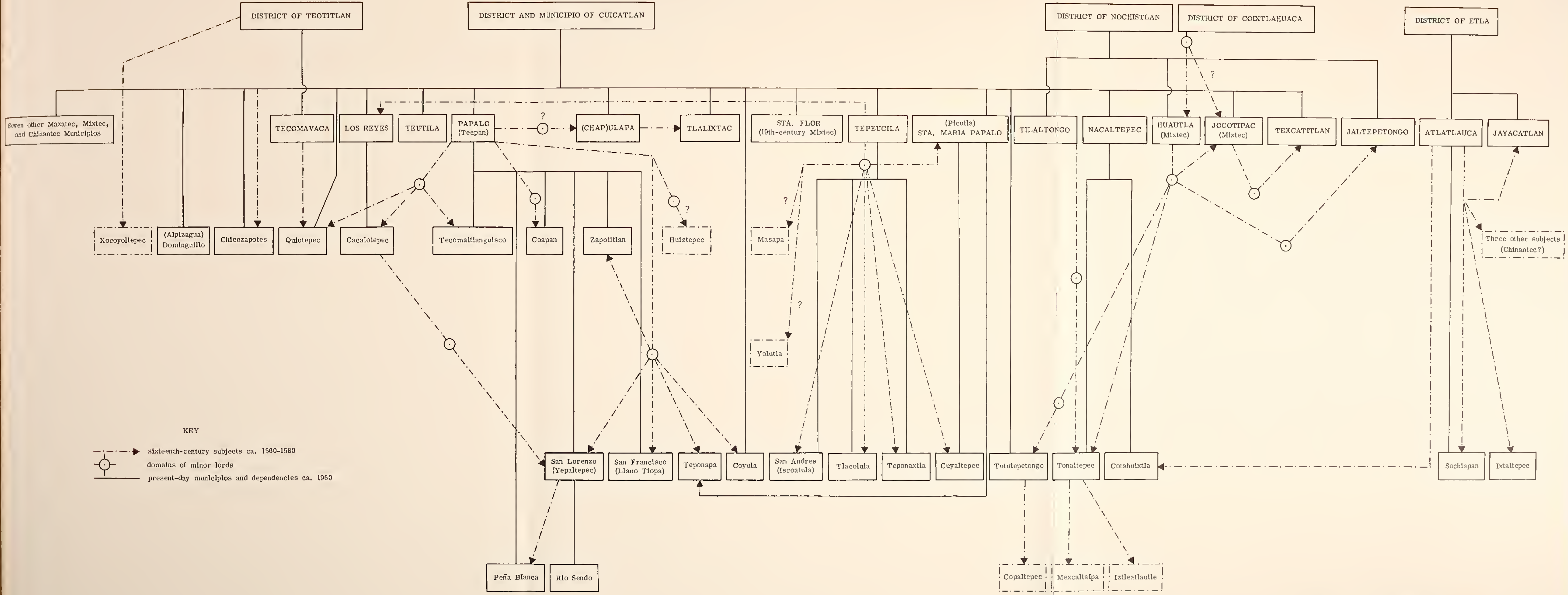


Fig. 82. Examples of changes of political authority within four hundred years. (Note: conflict of authority lines over San Lorenzo Yepaltepec and other settlements reflect conflicts of caique succession or Spanish reform.)

miento of Tepeucila; barrio of Tepeucila; rancho of the municipio of Santa María Papalo.
Contemporary: San Pedro Cuyaltepec (*yanin*?). Rancho of the municipio of Santa María Papalo (cf. Picutla above). Separated from Tepeucila after 1748 and before 1777-1778. Identification is uncertain.

Iscoatula, *nadecue, nyadecue, yadecue, na-'iko.*
Nahuatl: obsidian serpent of the place of rushes.
Cuicatec: worn-out town (?), in the mountain.
Changes in political status: estancia of the corregimiento of Tepcucila; barrio of Tepeuzila; municipalidad; rancho. Agencia of the municipio of Tepeucila.
Contemporary: San Andres Papalo (*yadecue, na'iko*). Rancho. Agencia of the municipio of Tepeucila.

Teponaxtla, Teponaztla, Teponastla. *dayyu*; *yando*; *indu'u.*
Nahuatl: land of wooden drums.
Cuicatec: ? place of adobes (?).
Changes in political status: estancia of the corregimiento of Tepeucila; pueblo of the República de Indios of Papalo; agencia of Tepeucila; rancho-municipal agency of the municipio of Tepeucila.
Contemporary: Teponaxtla (*indu'u*). Agencia municipal of the municipio of Tepeucila.

Tlacolula, *yagu, yagun, yajun.*
Nahuatl: terraced place.
Cuicatec: ? burning thorn (?).
Changes in political status: estancia of the cacicazgo of Tepeucila; pueblo of Papalo, of same *Doctrina*; municipalidad; rancho of the municipio of Tepeucila.
Contemporary: San Sebastian Tlacolula. Rancho. Agencia municipal of the municipio of Tepeucila. The pre-Hispanic settlement, according to Paddock, may have been the origin of the inhabitants of Tlacolula-Yagul in the valley of Oaxaca (Paddock 1962: 473). This interpretation, however, is based on an assumption for which there is no evidence: that the Cuicatec had joined the Mixtec in the invasion of the Oaxaca Valley (*op. cit.*, 472). The name may apply to innumerable towns since terracing was practiced extensively in the pre-Hispanic world.

On the northern border of the Cuicatec region at the confluence of the Rio Santo Domingo and the Rio Salado from the north lay Quiotepec, a minor cacicazgo of Mazatec speakers (IPCCS: 65; *ENE*, IV: 147; Ponce 1873: 268) (4). The major center to which Quiotepec belonged was Tecomavaca (old spelling Tecomahuaca[n]) in the southern tip of the Tehuacan Valley (R. de O.: 68; Catálogo de Pobladores (O'Gorman 1945) 506 (196); IPCCS: 31-33; Ponce 1873: 268; Villaseñor y Sanches 1748: 187; Robertson 1958, 1959).

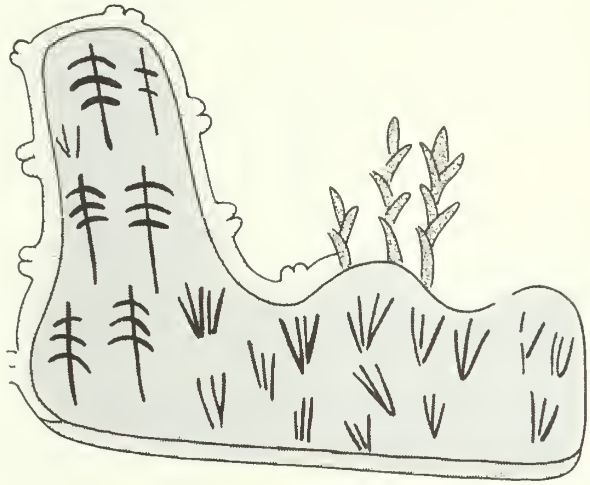


Fig. 84. Glyph of Quiotepec. Codex Fernando Leal, Lámina IX.

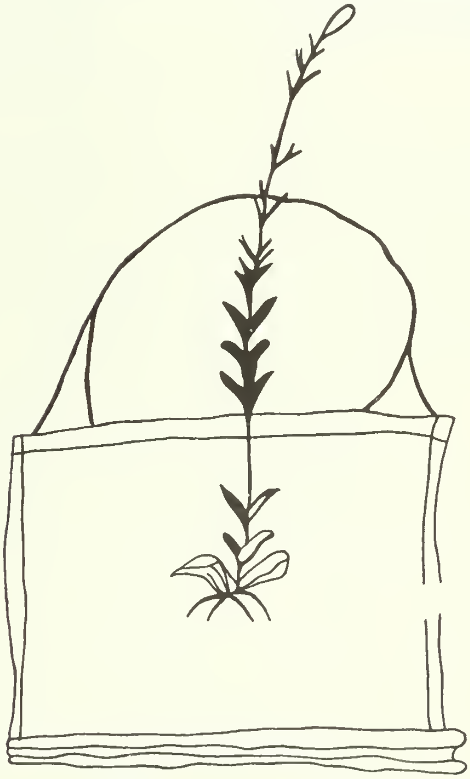


Fig. 85. Glyph of Quiotepec. Codice de Quiotepec y Cuicatlan.

Quiotepec.
Nahuatl: hill of shoots of agave.
Headtown of minor cacicazgo, attached to the cacicaz-

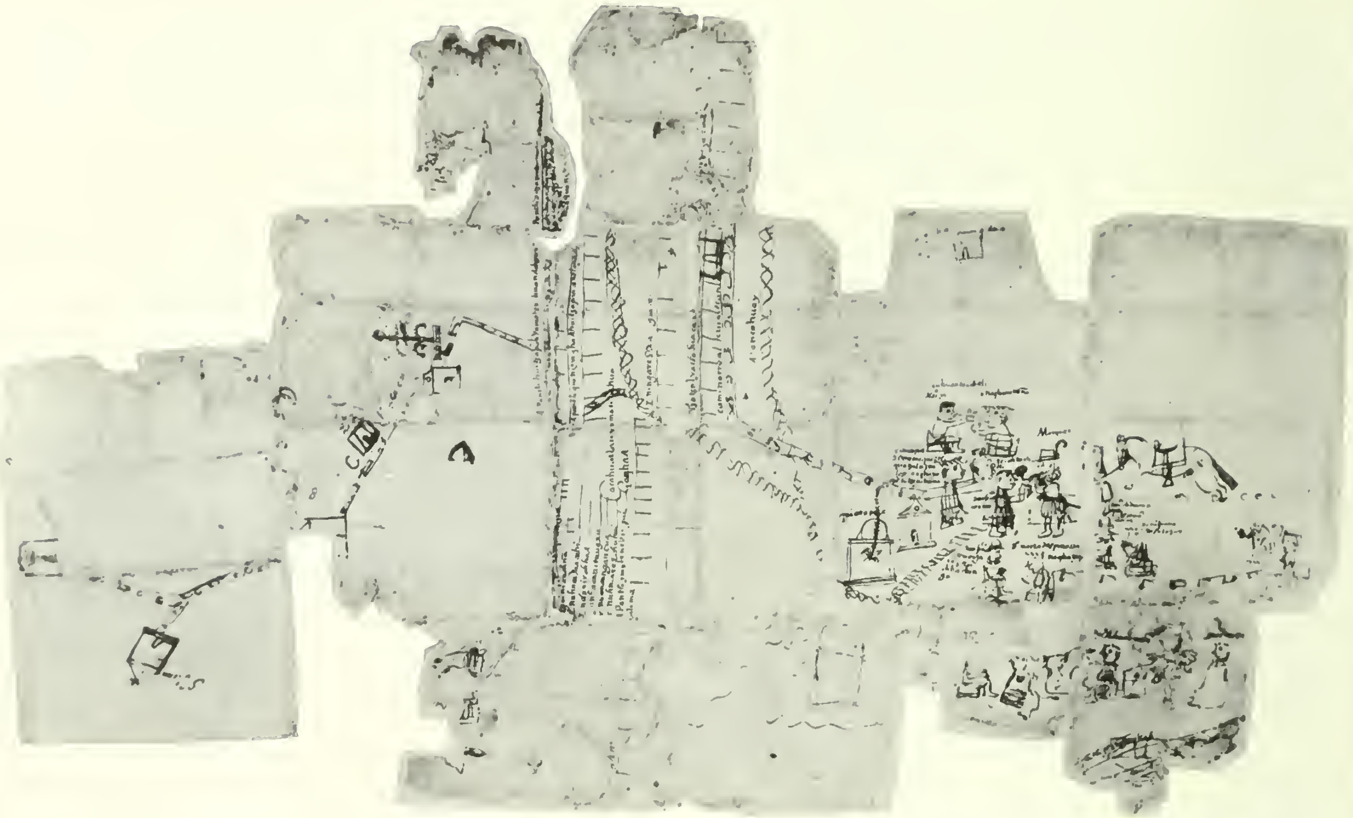


Fig. 86. Front page from Codice de Quiotepec y Cuicatlan. Library of Congress, Glass Census 266. The ladder-like lines in the central section of the drawing represent irrigation canals of Cacahuatlan and Huiztapan (?). These parallel the double spirals, representing the Rio Salado, and the Royal Road (double lines with outlines of feet) where it is shown running between the river and one of its tributaries. The river to the right is the Santo Domingo. Above the confluence of the Rios Salado and Santo Domingo the glyph of Quiotepec (Fig. 85) has been drawn, and to the right of this the genealogy of the Quiotepec Lords has been depicted. Above this near the top of the page is the glyph of the town of Tecomavaca. On the left, leading away from the irrigation canals, a road passes through a town with an unidentified glyph to old Cuyamecalco, old San Juan Coyula, and Sta. Maria Ixcatlan.

go of Tecomavaca-Salado; headtown of corregimiento; town attached to Ixcatlan (?); pueblo República de Indios Jurisdicción de Cuicatlán; pueblo subject of Cuicatlan; agencia municipal of the municipio of Cuicatlan.

Contemporary: Santiago Quiotepec. Agencia municipal of the municipio of Cuicatlan, Ex-Distrito of the same name. Quiotepec has an interesting history of decay from a politically powerful center to a minor town subject to the headtown of a neighboring cacicazgo. During the Classic Period it was a large fortified settlement. Its inhabitants fought against the Chichimec-Nonoalca in their migrations southward. After losing a war against Papalo (ca. 1172) the inhabitants moved north across the river and became dependent on the Mazatec allies of Tecomavaca. At the time of the Spanish Conquest they were a small cacicazgo settlement whose lords intermarried with Cuicatec cacique children of Papalo, Cuicatlan, and Tonaltepec. After 1562, the cacique lost a court suit against Papalo which cut down their free access to the water source for irrigation.

Llegada, or Recibimiento or La Raya.

Changes in political status: estancia of Quiotepec, subject settlement of Mazatecs; agencia municipal of Cuicatlan; agencia of the municipio of Cuyamecalco. Rancho subject of Cuicatlan.

Contemporary: San Francisco la Raya. Agencia municipal of the municipio of Cuicatlan. It probably became dependent on Cuicatlan when Quiotepec, its headtown, passed to Cuicatec jurisdiction. Its location is probably changed from the original hamlet site south of it and it is probably the same as Auacatlan on the Colonial map of Ixcatlan.

Tlecuaco or Tecazco.
Nahuatl: unknown.
Hamlet of the cacicazgo of Quiotepec somewhere south of San Juan Coatzospan and the Rio Santo Domingo.
Contemporary: unknown.

Santa María.
Estancia of the cacicazgo of Quiotepec.
Contemporary: uncertain. Probably the hamlet of Santa María Tecomavaca, named Santa María Quiotepec. May be the same which in the eighteenth century was named Santa María Tecuiltepec (?).

San Pedro.
Estancia of the cacicazgo of Quiotepec.
Contemporary: unknown.

To the north of the whole Cuicatec region today in the canyon of the Rio Santo Domingo, there were some Cuicatec settlements (estancias) subject to Papalo, but the major centers were dominated by the Mazatec. One of these, Tzinacantepec, is the present town of Chiquihuitlan. The largest, Teutila, which had "an Aztec garrison of 6000 men (*sic*)" at the time of the Conquest, was probably not Cuicatec (Catálogo de Pobladores (O'Gorman 1945): 506-546; Villaseñor y Sanches 1748: 187; Espinosa 1910 [1934 ed.]: 122-124, 152).

The present-day Cuicatec-speaking municipios in the region east of Teutila are evidence of the northeasterly movement of the Cuicatec. Otherwise, the general picture of the area is one of linguistic and territorial continuity.

Tzinacantepec.
Nahuatl: hill of bats.
Political status: unclear until the nineteenth century. Direct evidence is missing.
Contemporary: the inhabitants of Tzinacantepec moved, sometime during the Colonial Period, to the present town of Chiquihuitlan (Fig. 75). There is an involved contemporary myth having to do with this change of name and location. Apparently it was a consequence of the Aztec invasion, represented in the myth as the "attack of eagle men." Contemporary Chiquihuitlan is a defensive site atop a hill with deep gorges around it. Its population is primarily Mazatec.

Teutila, Teotitlan, *Dobahaku, kuetiako.*
Nahuatl: house of the God or Lord.
Cuicatec: place of many houses, or place of adobe

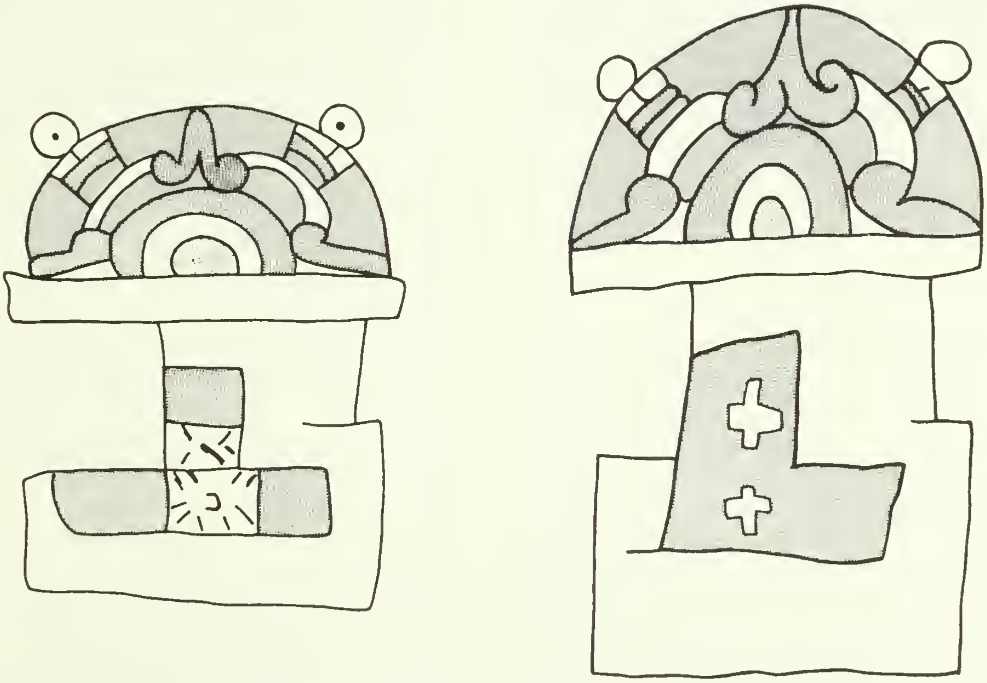


Fig. 87. Glyphs of Teutila (or Teotitlan?). Peñafiel 1885 (left) and Mendocino Codex, p. 45.

houses, or place of the pyramid of the Hill Lord ("Lightning").

Changes in political status: headtown of cacicazgo. Headtown of corregimiento, also alcaldía mayor for several towns of the Papalo-Tepeucila and the Chinantla regions, including Usila; headtown of República de Indios, with its own *gobierno* and Doctrina. Headtown of municipio of the same name. According to the *Suma de Visitas*, it had five subjects, not named (*PNE*, I: 288), each with its own estancias. One of these subjects was probably the present town of San Andrés Teotilalpan but, since this town was perhaps relocated, we do not know for sure its original site. The present location with its church, of a fortified pre-baroque style, indicates early sixteenth century occupation.

Contemporary: San Pedro Teutila. Headtown of the municipio of the same name, Ex-Distrito of Cuicatlan.

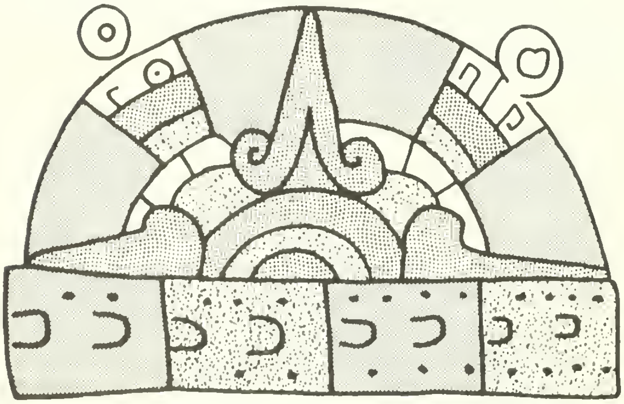


Fig. 88. Glyph of Teotilalpan (Teotlalpan: the cultivated lands assigned to a temple). Mendocino Codex, p. 51.

Our reconstruction of the nature of the Cuicatec states, the headtowns and subject settlements, is a tentative one, for our data is scanty and somewhat uneven. Although our earliest firmly dated source is as late as 1544, we think that all the settlements so noted were pre-Hispanic in origin. The Relación de los Obispados (Garcia Pimentel 1904) mentions most of the major settlements. The relaciones of the sixteenth and eighteenth centuries were our sources for the major cabeceras, Atlatlauca, Cuicatlan, Papalo, and Tepeucila. More extensive information on Papalo was found in the 1562 document (IPCCS) discussed more fully at the beginning of the chapter. Manuscript materials on the early sixteenth century, with valuable references to previous periods, appear here and there in the AGN Ramos. These and other sources in which the settlements appear follow in abbreviated form.

References (See Bibliography for complete references. Unpublished references are listed at the end of the chapter.)

Angulo y Mayo and Freeland, 1933-34.
Aragon Coronado, 1954 (unpublished).
Belmar, 1901.
Bernal, 1962: 3-16.
Boletín del AGN, XI #2 (data for 1560, 1786): 205, 209, 213.
Codex of Quiotepec (second half XVI cent.), in Glass, 1964.
Esteva, 1913.
Instituto de Geografía Card Catalogue, 1960 (unpublished).
IPCCS, 1562 (unpublished).
Maps of local districts prepared by teachers and missionaries (unpublished).
Maps of the Papaloapan Commission, 1950-1960.
Maps of the Secretaría de Defensa, Mexico, 1950-1960.
Martinez Gracida, 1883.
Memorias del Estado de Oaxaca, 1874-75.
Mexican censuses since 1900.
Paso y Troncoso, 1905 (*PNE*):
  Vol. I: 50-51, 74-75, 101, 186-187, 189-190, 196-197, 285-288.
  Vol. V: 9-23, 45-52, 88-89, 163-176, 183-189, 213-231.
Paso y Troncoso 1939-42 (*ENE*):
  Vol. 4: 130-148 (1544); 150-79 (1545).
  Vol. 6: 57-59 (1551).
  Vol. 9: 43-49 (1560).
  Vol. 13: 3-46 (1597).
  Vol. 14: 70-101 (no date); 122-139 (no date).
Perez, 1888.
Ponce, 1873: 260-271.
Relación de los Obispados (Garcia Pimentel 1904): 67-68, 74, 83-84, 93, 96.
Relaciones Geográficas del Siglo XVIII (1777) (unpublished — Paso y Troncoso copy, Vol. 99-100).
Villaseñor y Sanches 1748: 136-141, 144-145, 129, 187-189.

Irrigation

With an economy based on agriculture, the Cuicatec from protohistoric times to the present, have practised irrigation wherever the geography and hydrology permitted it. Those residing in the Cañada of necessity utilized irrigation exclusively (*PNE*, IV: 92, 172-173, 187-188). The Cañada region was, and is, one of the small nuclei of intensive irrigation, outside the Valley of Mexico. All Cuicatec settlements including those on the mountain flanks had irrigated lands, except Tepeucila where the local stream came to the surface through a salt mine and joined the Rio Grande over a cliff so that there are no alluvial flats, hence it was probably unusable for irrigation (*op. cit.*, 98). In the mountain towns the technique called "jugo" (juice or "tonamil") is used where the lands are high in moisture content due to surface drainage or stream overflow. It is possible that this technique which is at present used throughout the Cuicatec-speaking communities in places where irrigation is not possible, was also practiced in pre-Hispanic times, and preferred over the technique used in temporal lands which depend upon seasonal rain and are tilled by slash-and-burn techniques. The Spaniards remarked, that in the highland headtown of Papalo, horticultural products could be successfully cultivated because of the moisture (*PNE*, IV: 92 [#24]). These lands were listed separate from those producing crops with irrigation (*op. cit., loc. cit.*, #19). Cuicatecs today make a clear distinction among the three types of land, irrigated, moist, and dry temporal. The first two do not always require crop rotation, or fallowing practices. In the Chinantec side of the District, with its moist soils where irrigation was not necessary, tonamil crop lands were, in pre-Hispanic times, definitely favored (*PNE*, IV: 50). One advantage was the possibility of an extra winter crop (Weitlaner 1961).

Whenever the land is dry and a plot is available, irrigation is introduced. Even in communities depending primarily on production not requiring irrigation, irrigated plots are located wherever possible. The pre-Hispanic origin of this practice is suspected, even without direct information, from the complex native rituals and beliefs connected with the water used for irrigation and the extensive autochthonous ethnoscience connected with soils (for a detailed treatment of this kind of ethnoscientific analysis, see Reina 1967: 1-20). These rituals are found even in communities which depend primarily on seasonal rain.

The complete dependence on irrigated agriculture in the Cañada is an environmentally-determined necessity. Nothing that the Mesoamerican peasant planted as basic crops, nor that which the Cuicatecs cultivate today, can be grown there without irrigation. Once ditches and terraces for irrigation are abandoned, the land soon reverts to its original condition, capable only of supporting primitive hunters or gatherers.

Thus, Cuicatec communities, especially in the Cañada, follow the water. Through time there has been a slow re-shuffling of the cultivated lands of communities, and a moving away from worn-out land in the piedmont region. New hamlets, always move onto relatively level spots near sources that are sufficiently abundant in water to be used for more than household needs, so that the extra moisture waters sections of adjoining alluvial flats which can be planted. Through time the picture of the Cuicatec is one of a slowly moving kaleidoscope in which water is a focal element. Political affiliations of hamlets and minor communities may change, but today, as well as in the past, all important Cuicatec population centers, nucleated villages, and political units maintain their wealth and power primarily on the basis of intensive irrigation. For the present-day situation, one could argue that the hierarchy of communities is isomorphous on two axes, political and economic power, and the extent to which irrigation or wet agriculture is practiced. The only possible exception is the town of Teutila, now Mestizo, which bases its economy on the coffee trade (planted in humid temporal lands), established there ca. 1880 (Attolini 1949: 252), and the exchange of Indian corn to sell in the regional markets for manufactured goods.

The town of Cuicatlan today is located over sections of a pre-Hispanic counterpart (Fig. 89). Ceremonial complexes of buildings, including a ball court, house-sites, and ancient terracing littered with pottery extend beyond the present town in several directions, ringing the irrigated fields. Remains of house-sites appear wherever there is no modern habitation; two observed by us are adjacent to springs (Weitlaner 1955 and Verbitsky 1955, unpublished).

The existence of waterworks such as dams has not been determined archaeologically. The Fernandez Leal and Porfirio Diaz codices, however, contain several illustrations of waterworks which appear to be "native" in technology (the codices are probably post-Hispanic copies, or at least the Porfirio Diaz is). Although they have not been studied intensively, a primary checking has shown us that they are Cuicatec. They refer to the "history" of towns in the Cuicatec district, especially to military conflict, that is, war or wars over water (see Fig. 90). Since we have not yet attempted to study these codices in detail, a complete interpretation of hieroglyphs for the names of associated settlements is missing. Several hieroglyphs of places can be easily read as Cuicatec pueblos. Included are the "place of the butterfly" (Papalo), Atlatlauca (with a glyph similar to the one on the Mendocino Codex), "the place of the chicozapote tree" (San Pedro Chicozapotes), a "fortified hill with maguey shoots" (Quiotepec), a "hill of the hummingbird" (Tepeucila), "the hill of the bird

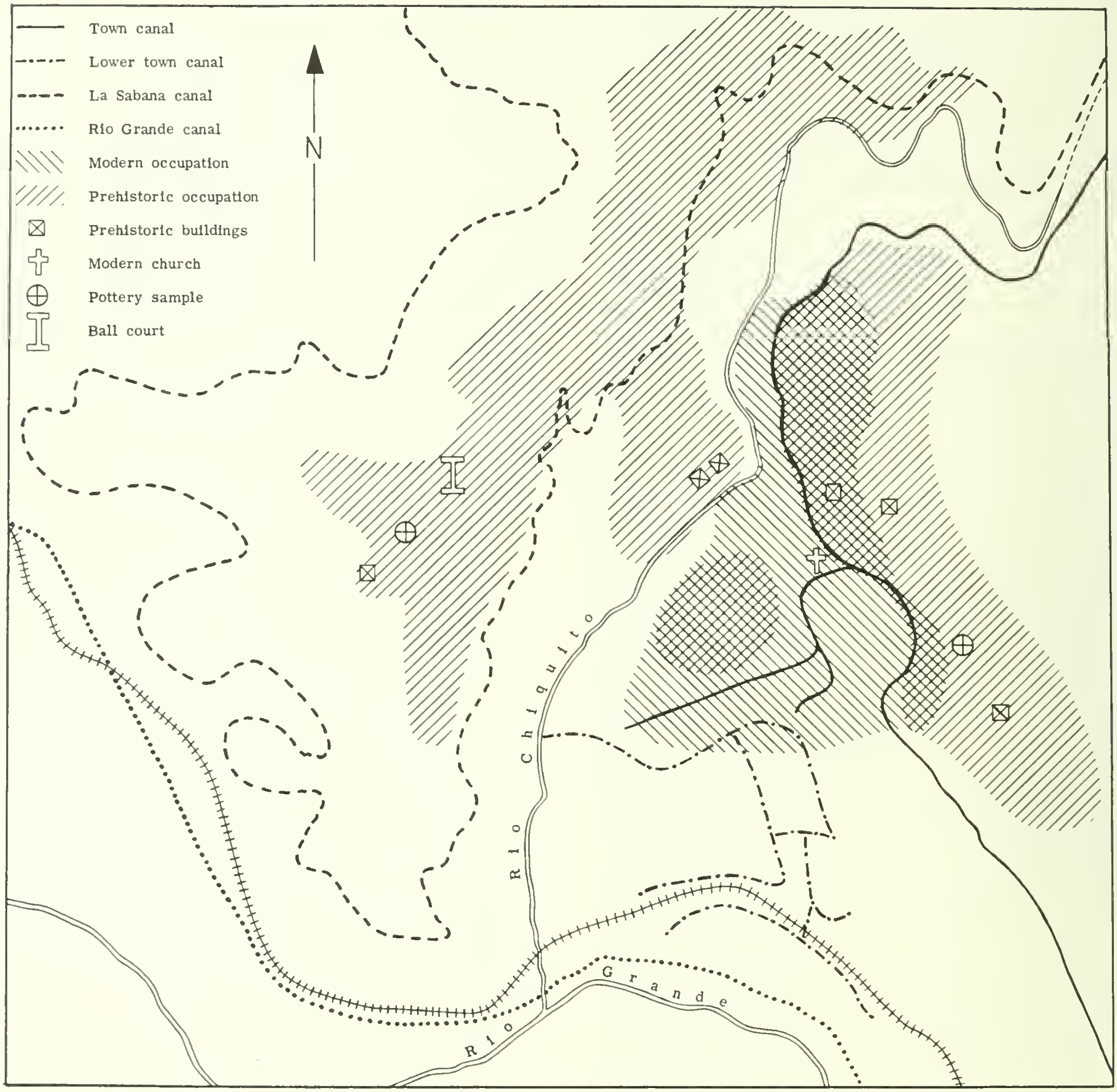


Fig. 89. Archaeological survey of Cuicatlan 1963.

(or parrot)" (Tututepetongo). These seem to be represented in the codex in geographical order. Two glyphs may, with loose reading, be Cuicatlan. Chavero (1892) identifies as Cuicatlan a figure in the Porfirio Diaz, from which the voice symbol emerges, but the meaning is highly dubious. Another one in the Fernandez Leal and the Porfirio Diaz Folio VIII, is a "hill with a head." The head is drawn in an extremely similar manner to the glyph of Cuicatlan in the Mendocino Codex (Fig. 79), but is missing the speech or singing symbol, and more probably represents Jayacatlan (the place of masks) which in other well-identified hieroglyphs appears represented as a head against a hill or boulder, and was one of Atlatlauca's subject towns (see Figs. 76, 78). A major river is always present in the paintings, surrounded by springs and associated hills. Irrigation canals, a fortified and terraced hill, and man-made waterworks appear in several, including an

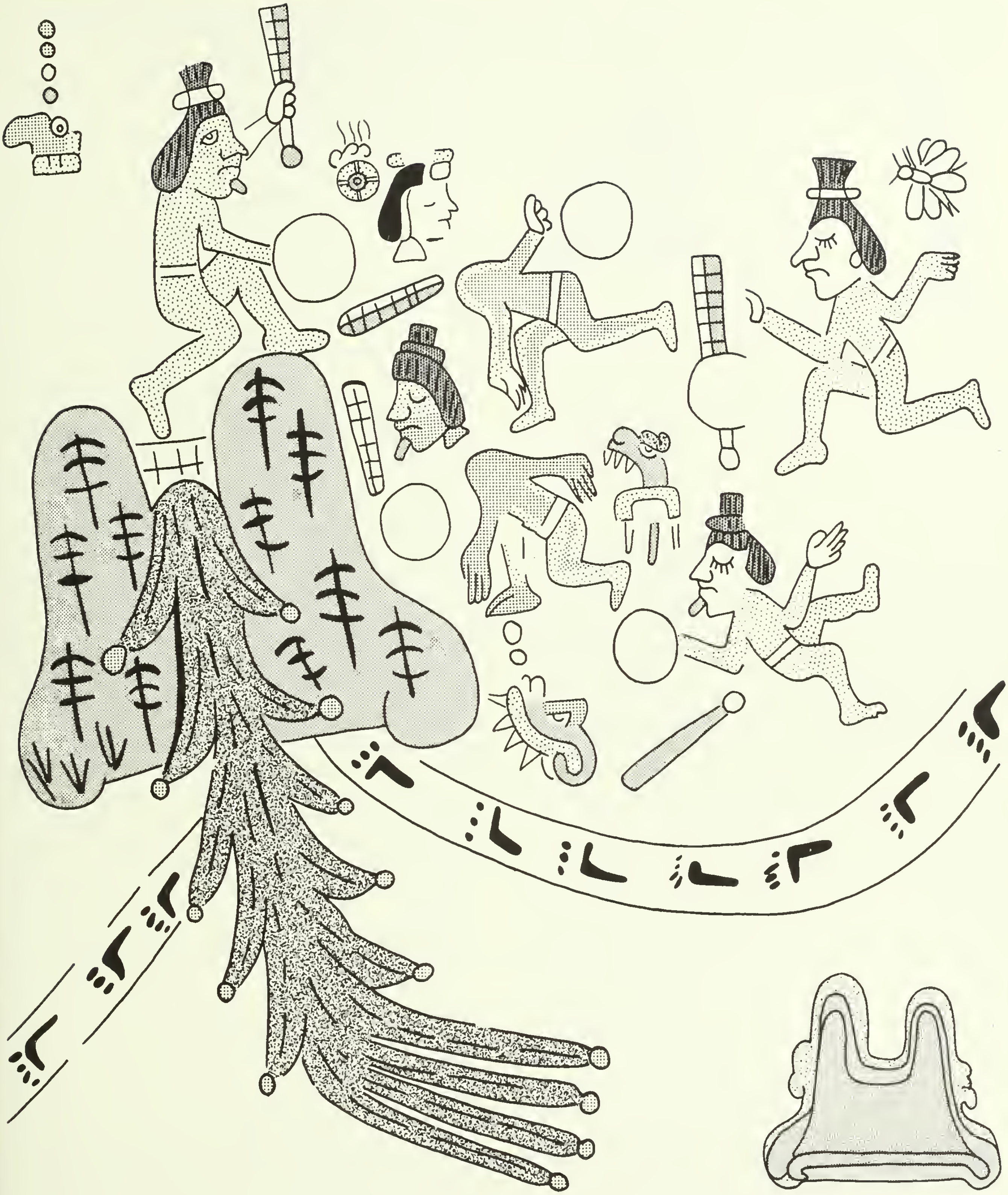


Fig. 90. Warfare at the site of a water spring with a sluice or dam (built of stone?). Fernandez Leal Codex, Láminas IV and V and Mendocino Codex, p. 33 (lower right).

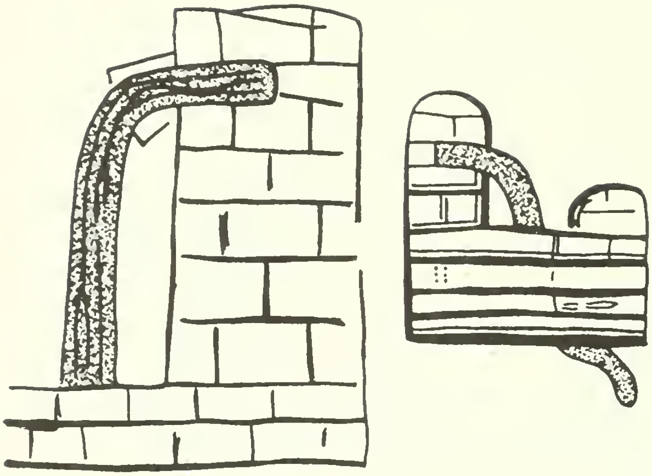


Fig. 91. Man-made water fountains (or sluices?). Codex Fernandez Leal, Lámina X Reverso (left) and Codex Porfirio Diaz, Lámina D.

aqueduct end, a dam (made of stone?) in the saddle between two hills with a guard or warrior standing on top and below which water flows, etc. (Codex Porfirio Diaz, Colombina Edition, Folios B, C, D, T, and R Recto; Codex Fernandez Leal, Folios IV, VI, and VII Recto, VIII-XI Reverso). This suggests the pre-Hispanic importance of waterworks. In this context I will discuss some contemporary evidence which is relevant to this analysis.

In the Cañada today there is an extensive network of closed, independent irrigation systems. In the major agricultural fields such systems function without any impressive or major permanent waterworks attached to them. There are, however, in the central part of the town of Cuicatlan, two types of permanent waterworks which are of marginal utility. A stone-faced and partially covered network of street ditches provides household water, and irrigates fruit trees in house yards. It is of Colonial origin and in a high state of disrepair. Each household keeps up its own household branch of the canal as it sees fit. The two major street canals are cleaned by the town because they service orchards located below the residential center. The Colonial government also built several small aqueducts, in the typical Spanish arch design, to service a few towns in the Cañada area (Martinez Gracida 1883). These are either in a major state of disrepair, as in Tomellin and Valerio Trujano where they are partially utilized in combination with open ditches, or abandoned totally as in Cuicatlan, and left waterless as a monument to a bygone era when organized, major building activities of civil improvement were still possible.

The bulk of the agricultural lands, however, are irrigated by extremely simple techniques. Two major feeder canals (*apantles*, from the Nahuatl word "*apantli*"), probably pre-Hispanic in origin, draw water from the Rio Chiquito, and serve the fields and orchards which surround the town of Cuicatlan itself (Martinez Gracida 1883). They are communally owned by the town. Ditches cover the whole of the irrigable land in the municipio like a spider web. They are open and shallow, with mudpacked walls. The deepest, a private ditch which uses Rio Grande water, is one meter in depth. Most of them, however, are between 30 and 40 cms. deep. In sandy spots, a simple rock or brick buttress against a cliff face supports them. Here and there a metal pipe or a hollow log, called a *canoa*, links the canal over a break in the terrain. Gates and sluices are temporarily built of piled up, uncut stones, mud and branches. *Tomas de agua*, the main diversion openings or "dams" from the stream, are built of mud and branches. Larger ones are built of chains of pyramids made of piled up branches, stuck in a semi-vertical position. These "dams" are called *chalchihuites* (Nahuatl: green stones, or necklace of precious green stones), a poetic rendering of a symbol associated with surface water and its goddess, Chalchihuitlicue, companion of Tlaloc, in pre-Hispanic times (Florentine Codex, Vol. 1: 6-7; Caso 1953; Piña Chan 1960: 80, 81, 84, 115). Chalchihuites are easily washed away by freshlets or strong currents so that constant servicing is necessary. Cleaning the canals and opening and closing sections of ditches and chalchihuites are simple but tiresome and frequent tasks, and, where controlled by the local water authorities (i.e., the town Water Commission) takes up the larger part of the communal town labor. One cleaning of the Sabana canal, one of the two major feeders from the Chiquito River (Fig. 89), required two full days of work for 115 men which, at the local average of 6.5 hours per day, amounts to about 746 man-hours. For maintenance of the few large privately controlled canals one or two laborers are permanently hired for continuous work. Extra crews of five to ten men are routinely hired for major cleaning and repair. In addition they may be hired for various periods of time to take care of emergencies. In one instance during a rainy season when a chalchihuite chain broke in a privately owned canal because of the strong river current, seven men took five days to repair twenty meters of chalchihuites. This work was done under difficult conditions and cost 350 pesos.

The cost of maintenance of one private canal for its "owner," including regular and emergency crews and policing, was calculated to be approximately 8,000 pesos per year. Since this private canal serves at least ten clients, who pay for the water, plus its "owner," over half of the cost of maintaining it is paid by the customers. However the significant factor is not necessarily profit or cash costs, but rather the links of dependency which are created by the alternative systems of canal control and land tenure.

During the planting and growing season, crews of laborers are regularly at work under the supervision of canal owners, foremen employed by them, or officers of the town Water Commission who are sometimes aided by the municipal authorities. To cover the cost of maintaining the irrigation canals in proper condition, clients receiving water from a public canal pay the Water Commission either in cash, or in the number of laborers which they are expected to provide. The costs are assigned to each water client on a *pro rata* basis, that is, according to the size of the crop planted measured in seed (*maquilas*), or by surface area (hectares). Thus, a man drawing water from a public canal is expected to provide maintenance service proportional to his consumption of water. Large land-owners who are drawing water from public canals hire men of the lower class to perform their share of the cleaning. Small land-owners and the renters do the work themselves, sometimes with the help of kinsmen.

All cultivators pay for the water they receive, separately from the payment for maintenance. Payments are made by individual arrangement. The arrangements are varied: a man can pay an hourly rate, by the number of waterings he receives during the growing season, or by the total water requirements of the specific crops he has planted. For example, watering rice and tomatoes costs more than watering corn.

The income of the Water Commission is used to defray the costs of the irrigation system, including the salaries of the Commission employees.

Both private canal owners and the Water Commission have permanent crews in charge of opening and closing sluice gates which divert water to the fields. These men, called *jueces de agua* ("water judges"), also have water policing duties. They make decisions as to who needs a watering, the length of time that water is allowed to flow in each feeder canal, and the arrangement of watering schedules for specific fields or orchards. They are armed to prevent farmers from stealing water. In seasons where water is in short supply, stealing water is very commonly engaged in by owners of neighboring parcels of irrigated land, especially at night when visibility is poor. This is one of the reasons why most townsmen prefer to irrigate during the daytime, in spite of the fact that the volume of water per hour is greater at night, due to a much lower evaporation rate. Other factors are the disruption of sleep and work schedules, and the supernatural dangers associated with the night.

In addition to labor management and water allocation problems, there are engineering requirements built into an irrigation system such as the one in Cuicatlan. Although there is very little permanent masonry construction, the primitively-built sluices and canals require considerable engineering skill in their construction and maintenance. The main canals, and the major feeder canals are long (an average of 10 km.), and have to be taken off far upstream, making gradient a crucial matter. To maintain minimum standards of efficiency, decisions on when and how well to repair the system, especially in the wet season, require skilled decision making. Waiting too long to repair a dam may result in discovering that it has been totally destroyed by the current. If repairs are made too soon, often the labor costs are higher than necessary, thus deflecting scarce resources from more productive pursuits.

To complicate this normative picture, there are irregular and illegal aspects of the irrigation system which are omnipresent.

Water is federally owned and in theory is available in an egalitarian fashion to all potential users who take regular turns at being served and who pay identical rates of taxation. However, this ideal picture of an egalitarian system of water distribution, maintained by an egalitarian system of duties with respect to the physical maintenance of canal networks, is complicated by a complex system of water or canal and land tenure and the varying water demands of the crops planted. Land in Cuicatlan is owned privately by individuals, family trusts, and private corporations and cooperatively by the local *ejidatarios* and the town corporation to grant in usufruct. Some land can be rented, leased by long-term contracts, mortgaged, and so forth. An additional complication is that permanent standing crops such as fruit trees can be sold, rented or leased independent of the land on which they stand. The origin of this practice is pre-Hispanic (Millon 1955). Furthermore, several alternative ways of watering are available; for example, using the water from town-controlled canals, building one's own feeder canal and renting water rights from the town or adjacent settlements, or renting from private canal owners. In times of shortage individuals who draw water from the private canals by paying its "owner" cannot easily obtain water from the communal town sources because they are not habitually included in its schedules and do not participate in Water Commission affairs. However, if a particular user "does not pay his share" in bribing costs, or does not support a political candidate, or refuses to sell his harvest to the man who gives him credit and water, he can be easily punished by having his water supply cut off. This means the ruin of his crop or the sizable reduction of his basic income (cf. Simpson 1937: 370-371 for a comparable case).

One result of this complex picture is that conflict is generated by the contradiction between the normative expectations of the majority of water users, and the actual practice of distribution. Since the Revolution, there has been an egalitarian ideology with respect to access to irrigation water. This has been written into federal law and has been applied to the formation of bureaucratic mechanisms for water distribution. However, the actual situation in Cuicatlan reveals highly varied methods of control of land and water resources. The private control of land, water scarcity, the dissimilar water demands of the various crops planted, the great differences in size and quality of fields, as well as the differences in wealth and power of the men involved, all affect water allocations. Because of the contrast between potential or ideal versus actual access to water, the resultant constant petty conflict often develops into physical aggression and even homicide.

Another question of conflict lies in the degree of centralization of the control system. In this instance, the question is how the Cuicatlan social system copes with this conflict. At first glance the system seems to be highly centralized due to the existence of a single Water Commission. At second glance, it would appear to be decentralized, for there is not a single unified decision-making body, but at least three such (the Commission, the municipal government, and the Ejido Commission); and in addition, the wealthier landowners who are also private canal owners exert pressures of their own. In fact, the control is both centralized and not centralized, depending upon the definition of "centralized" in reference to water allocation, conflict resolution, or other variables; or in terms of the degree of centralization of the larger political system in which irrigation is embedded. The conflict is kept under control by the effective use of legitimate force, employed by several local government agencies which are coordinated in their actions (e.g., the Water Commission and the local police), and by the pressure of the wealthier landowners. Moreover, the Cuicatlan elite have unified decision making by effectively controlling all dimensions of the body politic. This situation has existed for several centuries.

During the Colonial Period, the town authorities controlled the water system under the supervision of the Spanish officials. The small population size apparently prevented major conflicts over access to water, judging by the absence of court cases. In the nineteenth century, the municipal authorities controlled the water system for the whole municipio throughout the District. Some of the haciendas of the area were treated by the Colonial government as separate political entities (*municipalidades*) and controlled their own water systems, for example Tecomaxtlahuaca and Güendulain. A few small haciendas, however, were totally within the Cuicatlan municipal boundaries (e.g., el Zapotillo and Obos), and secured water from the town's municipal system. One *hacendado* owned his own aqueduct within the municipio. There was thus a single decision-making source for all of the users of any one municipal system. But the hacendados controlled district politics including water politics and used this control for their own benefit, irrelevant of municipal regulations (cf. also Martinez Gracida 1883).

Following the Mexican Revolution, the local small farmers claimed that gross injustices in the distribution of water existed, due to the control of the municipio and the local government by the largest and wealthiest landowners. This control became more disruptive with the great increase in population and the demands upon the water system for new, water-hungry cash crops. The Cuicatlan Water Commission was created after the Revolution and was to be a separate agency directly and officially responsible to the federal government. Its creation was an attempt to remove undue influences, and to resolve some of the past conflicts and alleged corruptions which interfered with an equal and just distribution of irrigation water. Decision-making power over water was therefore officially centralized in a single agency, but it was also separated from other decision-making bodies which affected the whole community (especially the municipal government). In theory, control of water thus became unified, insulated from other political controls, and located both above and below the municipal level. This was to prevent interference of the locally influential power groups (the local landed elite) in matters of water control, and vest power on the local water users who elected representatives from among themselves.

What in fact has happened, however, is that the local elite now controls the Water Commission through their political clients who are the office-holders in that agency. This is in addition to their analogous control of the other formal government bodies in town. Many of the poor in Cuicatlan now believe that the solution to the present problem is to bring men in from the outside to manage the water system. Others believe that they should go back to the old system of municipal control, "without its corrupt elements." No one suggests, however, that they can do without some sort of unified control, nor can they suggest ways to eliminate corruption except by increasing water supplies to meet current demands. One of our informants summarized their problem by stating flatly that "water makes people dishonest and peaceful men fight. If there is not enough, even the most honest man will be tempted to get an unfair share for himself and his friends . . . if he can find the way."

The Papaloapan Commission (cf. Poleman 1964) has tried to solve the problem of shortage (which greatly affects production levels for the district) by proposing a diversion dam and a new canal from the Rio Grande which will increase the amount of water available for irrigation and increase the area of land which can be regularly irrigated by a maximum of two-thirds of the present area. This project has been looked upon with jaundiced eyes by the local landed elite because among them water is a profitable business. For example, those who had the capital or who could obtain credit to pay for the labor can maintain large open canals for their own use. This enables them to sell water illegally under the guise of selling services such as canal maintenance and thus reduce their own water costs. This is a sizable source of cost saving on canal maintenance for the contemporary upper class and more important, because of the ties of dependency it creates with water clients, a source of political power. The landed "aristocracy" controls not only water and the best lands but also controls local export and import commerce, credit, the officership in the *ayuntamiento*, the local branch of the PRI, the candidacy of state congressmen and their own rates of taxation. This latter can be regulated either by bribing the local civil servants or through lobbying or personal connections at the state and federal levels. Bribing, uneven allocation of water, excessive water taxation of the poor, water theft, and other injustices in the access to irrigation are complaints which are no different today than they were in the nineteenth century. However, the system functions fairly smoothly in spite of constant petty conflict and there is no evidence to indicate that it may collapse. During the rainy season, about half of the year, all fields receive sufficient water. In the dry season, the small cultivators do not plant a second crop, or plant a crop with low water requirements, or grow a stunted crop with insufficient water. They do not like it, but they cannot, at present, change the structure without another major local "revolution." The centralization of power over water, united with other sources of political strength on the part of the local ruling class, prevents the reform of the irrigation system, and keeps conflict from running rampant.

Centralization of authority in the context of irrigation systems refers to different kinds of unified social control, i.e., to several different variables. In addition to responsibility for construction and maintenance of the canal system, we must include rights to water allocation, a major variable (Millon 1962), services connected with resolution of conflict between water users, duties connected with the defense of water resources and irrigated land, the proper performance of rituals insuring water supplies, and so on. These may involve a single institution, or a role, or a set of ranked specialized roles. For examples of centralizing institutions, one may look at the water cooperatives of Japan or the "irrigation societies" of Bali (Beardsley, Hall, and Ward 1959: Geertz 1959, 1963). A small water society in Bali, the minimum *seka-subak*, is a corporate body whose estate is water, and which centralizes authority over single water sources and their canals and dams, and regulates the use of water by its members independent of their individual membership in other corporate units in the society such as hamlets or villages. Millon (1962) believes such "water cooperatives" are decentralized. Given our definition, however, they are centralized in several variables. Each Balinese irrigation society (seka-subak) has an elected chief, usually called *Klian subak* (Geertz 1959: 996). Moreover, not everyone in a seka-subak is involved in all activities. There is, for example, a part of the membership called the "water group" which carries on the actual irrigation work in exchange for a money payment. Different levels of institutional centralization of water-seka existed simultaneously in Bali. Three levels at least are mentioned by Geertz (*op. cit.*): the top level controls a watershed and is coordinated by officials of the central government which are involved in improving ". . . inter-subak coordination" (*op cit.*: 996). Furthermore, Geertz makes it more than clear that the Balinese are organized in a centralized, state political system controlled in the past by an aristocratic elite (gentry) which today monopolizes ". . . the Balinese branch of the Indonesian civil service" as in the past they ". . . almost completely monopolized the interlocal, superordinate political and religious roles of the traditional Balinese state structure" (*op. cit.*: 997). If there was any doubt as to our reading of the earlier evidence, in a more recent work (Geertz 1963) the information on the irrigation sekas is even more to the point. Traditional rural Balinese society is arranged as a series of cross-cutting corporate structures, each with its own authority hierarchy, of which one of the major ones are the irrigation and agricultural societies (i.e., the seka-subak). Geertz argues that such organizations have multiple functions, in addition to irrigation as such. They are also involved in agricultural decision-making, and in ritual since they maintain their own two temples to the goddess of fertility and the god of water (*op. cit.*, 91). Recently, the sekas had been managed by specialized work crews which have replaced " . . . the egalitarian mutual cooperation of the traditional irrigation group." Moreover, "the final stage of this process is perhaps represented by the (admittedly still unusual) formation under energetic rural entrepreneurs, of wholly professional water sekas, composed almost entirely of landless villagers who belong to no irrigation society at all, and which hire out, on a jobbing basis, to perform the water management tasks for three or four different irrigation societies" (*op cit.*, 92).

As to the role of the aristocratic political elite in the institutional centralization of authority over irrigation, Geertz has some interesting things to say. He believes that "the role of the state in irrigation matters can easily be much exaggerated — as it has been, for Bali, at least, in Wittfogel's recent treatment of 'Oriental despotism' — " (*op cit.*, 105). However, he does not deny but directly confirms the role of the elite in centralizing and politicizing irrigation. On the one hand, "the irrigation societies were self-directing associations of those directly involved and not mere appendages of a central bureaucracy" (*loc. cit.*). But on the other hand, irrigation cannot be called decentralized, because in Bali, "In irrigation, too, the lords played an important role in coordinating activities between irrigation societies and settling interlocal disputes, granting rights to clear new land, build new dams and form new societies, and so on. Usually, a member of the royal house was appointed general overseer of irrigation for the whole region and each noble house had one or two irrigation officials of its own" (Geertz 1963).

Centralized authority may refer, not to an institution, but to a set of separate roles which specialize in controlling water allocation, labor management, defensive warfare over water, internal conflict resolution for a particular irrigation system, and so on. For example, the role of water judges in Mexico centralizes arbitration and conflict resolution, as did those in medieval Spain (cf. Glick 1970). The role of the *hakim*, or tribal judges, of Nahid is another example (cited in Millon 1962).

Millon says, and we strongly agree, that "dependence upon a common irrigation system has strong potentialities for antagonisms and social disruption, as well as for cooperation." (Millon 1962: 56) One would like to ask then what is the relationship between degrees of centralization and levels of conflict in the irrigation society. Or, one could ask what are the functions of centralization, and what is the adaptive value of centralization in the context of conflict? We hypothesize that one condition in which centralization of authority is adaptive in reducing conflict is under conditions of water scarcity, and that this is particularly true in a system of food production that is totally dependent upon irrigation agriculture. The reason for this is suggested by Millon's comparative materials since they show that without unified decision-making high levels of social disruption and conflict will tend to paralyze the socio-economic system. In the long run, over long periods of time, the threat of anarchic conflict will generate further pressure to centralize the system, if it is to survive. However, stating that a variable is logically or functionally adaptive, does not necessarily imply that it will always be adopted. Secondly, centralization of decision-making over water is probably not adaptive under all conditions, and it is most likely adaptive only up to the maximum territorial extension of the particular irrigation system. We suggest, hence, that when water becomes a scarce resource, water control, e.g. the control of springs, water allocation, etc., can be manipulated to diminish or increase conflict for political purposes within the political system in which the irrigation system is embedded.

The picture of water control in Tanganyika, post-English Colonial Iraq, or in modern Teotihaucan or Cuicatlan cannot be used to explain the original evolutionary conditions under which water control did or did not become a significant factor in political centralization in any or all societies. It is obvious, however, that in some instances one could make inferences from a documented comparative perspective or from diachronic information.

The relevance of case studies, historical or contemporary, is not that they provide final answers, but that they illustrate the complexity of the problem and the high degree of variation of functional adaptations. Moreover, many case studies of contemporary societies may serve to illuminate the interpretation of historical cases. Our evidence from present-day Cuicatlan, for example, may clarify some of the analyses of sixteenth-century Cuicatec society, as long as we keep in mind the differences as well as the similarities between the social systems.

The contemporary Cuicatec evidence indicates that to maintain even a primitive canal system in this area, minor but time-consuming frequent activities are necessary. And, control of decisions concerning water resources, perhaps combined with the control of other scarce resources such as land or trade, may create the conditions necessary for the monopoly of political power. Moreover, they appear to point out as a working hypothesis that irrigation creates conflict, as well as cohesion, but that conflict and centralization are inversely related!

Even though four hunderd years have elapsed and much water has passed through the canals, the picture at the time of the Conquest had some similar outlines. The techniques of irrigation have not changed greatly and if they have changed at all, it is probably toward primitivization. That is, it is possible, as the codices appear to document, that more complex techniques of water control existed in pre-Hispanic times. This is certainly true of the Colonial Period during which some local masonry aqueducts, now in disrepair and unusable, were built and maintained. However, there have been significant changes in other structural factors. Private land ownership which by definition changes the total picture of the social organization of an irrigation society does not appear to have existed in pre-Hispanic times. Such variables as wages are of recent introduction. Nevertheless we know that the aboriginal Cuicatec had communal work (*tequios*), that decisions as to activities were made by the local rulers (caciques) and that local government authorities (caciques, tequitlatos and other offices) supervised the laborers (*PNE*, IV: 168; IPCCS passim). We do not know whether the caciques (lords) or the tequitlatos (hamlet or barrio stewards) were in charge of daily water allocations. In either case the local government apparatus was in control of centralized decision-making for its town's own canal system. We also know that the caciques were the collectors of water tribute on a seasonal basis from communities which used the water controlled by the community which they governed; they were the depositories of the administration rights of communal waters and lands as will be discussed below, and were primarily responsible for defensive warfare against groups encroaching on their water sources. In the sixteenth century, caciques, as their contemporary counterparts do today, manipulated water control as a source of power to obtain a political following as is shown in the discussion of the Yepaltepec-Quiotepec case below. It is not clear at the present time whether they had any other gross income or power that might have been derived from water control.

Hence, it is possible to argue two ways: that in the sixteenth century as today, (a) the elite controlled water because they had centralized political power in their hands and, (b) water control was one of the sources of their political power. However, the system of irrigation as it exists today in the canyon, and as it existed at the time of the Conquest, has clearly discernible requirements related to the social need for technical and managerial skills and for centralization of decision-making to avoid conflict. Without effective control of the technological aspects, the irrigation network can physically collapse in a very short time. Without effective control of the sociological aspects, the irrigation society can fall into anomic internal conflict and the normal flow of production and peaceful neighborly coexistence would soon be disrupted.

The hypothetical possibility that an irrigation network such as that at Cuicatlan could be created and maintained without (a) a body of technical specialists and (b) an institution or set of roles designed specifically to unify decision-making, is unlikely. Such a situation would best be described as one in which each domestic group, or a handful of domestic groups, could satisfactorily construct and maintain an irrigation system taking water from a single source, and pass it on to everyone involved in an egalitarian fashion without policing it and without major conflict. It is perhaps the case that the earliest irrigation systems in Mesoamerica, especially in small valley hamlets such as those MacNeish calls barranca hamlets in the Tehuacan region, were put together this way; that is, by a few domestic groups acting in unison for the common good.

As soon as a system becomes sufficiently large, such as in Postclassic and contemporary Cuicatlan, it seems to become inefficient, and it is unlikely, and perhaps impossible over the long run, that the people could work this way without great waste of energy on distracting conflict and anomic decision making. Under such conditions, construction, and especially maintenance and policing, will probably become concentrated in an institutionalized role or set of roles, which are specialized in function, as indeed happened in Cuicatlan. First of all, as we have indicated, in order that a large number of domestic groups may use water from a single diversion dam from a natural source, considerable engineering skill is required to build the major canal. As we see in the example of contemporary Cuicatlan, the maintenance of a major or core system is also a complicated undertaking. In systems of this type, normal maintenance is a constant chore, and decisions have to be made every day about how much work is needed and where. Then the work has to be supervised in order that it is done properly and without damage. There are emergencies to be coped with and this requires the ability to mobilize a substantial number of workers on short notice and to get them to do the work effectively. In arid lands, with population pressure creating a need for additional water supplies, policing the system is also a serious consideration, both in scheduling water allocations and protecting the receivers of the water: it is also necessary to detect theft of water and, most seriously, to resolve satisfactorily the conflict which arises over competition for a life-giving scarce resource. Bookkeeping for the system is of some importance. The work has to be exchanged for money or other privileges or the individual workers must be convinced or coerced into carrying out the work. The individual clients have to receive the amount of water which is regarded as their due and for which they may exchange either labor, tax, or tribute. For a large system involving scores of domestic groups, routine administration, even when thoroughly traditionalized and free of conflict as in Pul Eliya (Leach 1961), is complex and vital to the survival of the system. Mismanagement of the administrative duties is likely to provoke open antagonisms. Lack of unified decision-making may lead to anarchy, while injustices of distribution may steadily build tension and conflict, to the point of social collapse. Centralization of authority may function, however, to prevent such extreme developments.

If an irrigation system is thus large enough it may encourage, if not require, that several functions be centralized by being allocated to specialized roles requiring skills which are relatively scarce when compared with other roles in the same social system. Today, even with the simple technological aspects of irrigation in Cuicatlan, there is a differential distribution of knowledge; especially of engineering, organization, and supervisory ability, and of access to information. It is probably not necessary that all of these skills co-occur in the same role, at least in the beginning. The construction and maintenance systems at early stages in the development of a small irrigation system are probably not differentiated from other administrative or leadership qualifications. That is, the technological, organizational, and supervisory skills appear to be closely related (bookkeeping may well be another skill). Once the system becomes large enough, however, it is necessary that the same institution or role-set be defined and occupied by personnel which have at the same time the capacity and power to use their conflict resolution skills.

Regardless of the likelihood that, when the earlier, smaller Cuicatec system commenced to function, these skills were distributed among different persons and authority was allocated in a decentralized fashion, it is certainly true in the sixteenth as well as the twentieth century in Cuicatlan that individuals combined all these skills into the same roles and that such leadership roles were and are stabilized in the social system within the system of stratification. This generation of specialized political institutions or roles which cope with irrigation is what we mean by the centralization of power, or unification of decision making, which is adaptive in this irrigation system.

The specialized roles, by virtue of their position in the irrigation system, are intimately related to the distribution of power in the society. This is true even in simple stateless societies such as Sonjo (Gray 1963). By virtue of their control of water such roles can generate power in other realms of the irrigation society. That is, they can generate a ranked division of labor and differentially distributed economic surplus, which in turn permits greater differential control over labor and capital for the construction and maintenance of the system. Such roles are thus potentially a springboard to other realms of power and control. However, in all probability there is a feedback loop involved here. Power in other realms of the society will probably increase the likelihood that particular persons will either assume themselves or be recruited to fill the decision-making roles connected with irrigation. At this time, we see nothing in our data which permits us to legitimately decide to make irrigation either the independent or dependent variable, when considered with other kinds of systems within the same society. But neither can we suggest from the empirical evidence that the irrigation system is epiphenomenal to the political process or to the degrees of centralization of authority which may be most adaptive to maintain social conflict at low levels. On the contrary, irrigation appears to be, at least for Cuicatlan (the system being considered) one of the major foci of the political field.

From the superficial evidence of the ancient terraces it appears that the old Cuicatlan system was as large or even larger than the contemporaneous one. The older Rio Chiquito canals appear to have been built higher up the slopes irrigating an area above and including the present one. Below the Rio Chiquito alluvial terrace there are two canal networks which take their water from the Rio Grande to irrigate sugar cane plantations. Three crops introduced by the Spanish, sugar, mango, and rice, have much higher water demands than native crops (*PNE*, IV: 173). Introducing a high water-demand crop substantially reduces the area of the territory which can be cultivated, and added water supplies were needed. Other crops were introduced by the Spaniards into the region and took successfully to their new home. However they did not involve the irrigated lands, but instead were grown in the higher cooler temporal areas (peach, walnut, and coffee primarily). The early Cuicatecs, however, planted a large variety of products: corn, beans, chiles, tomatoes, and other native staples, plus orchards of chicozapotes, avocados, native plums (*obos*), mamey and some cotton (*PNE*, IV: 97, 171, 173-174, 187-188). All these except cotton are planted today extensively as cash crops, in irrigated commercial enterprises. Old cotton "trees" or bushes, grow wild today in areas where no human occupation is near. Some of the Indians from poorer villages gather it and sell it locally. Most of the cotton, raw, employed today for weaving, is traded with the cotton producing area of Tuxtepec through Chinantec middlemen. Other products gathered from the same region between lowland Cañada and mountain town occupation, are wild edibles: small cactus fruits, a variety of wild artichoke, blackberries, mesquite seeds, etc. The same was true in the sixteenth century. Hence, the irrigated agricultural production of the region has been, with the exception of the three major post-Hispanic introductions, stable since pre-Hispanic times. Cuicatec corn fields and orchards were extensive and productive enough to cause the Spaniards to remark upon them with pride, even though they were prone to complain of the isolation and beastly climate of the region (*PNE*, IV: 91-92, 172-173; *ENE*, VI: 31, 57-59). Large irrigation works, however, are not mentioned in the Spanish accounts. The primary sources indicate that the water used was primarily that of affluents of the Rio Grande, rather than the river itself (*PNE*, IV: 92, 172-173, 187-188; IPCCS: 23-25, 31, 32 passim). This situation persists to the present. Cuicatlan today uses Rio Grande waters only in the land immediately adjacent to and slightly above the flood plain; the ditches are new, having been dug in the twentieth century.

The irrigated sections of separate states were discontinuous, as they are now, each covered by a separate, nonconnected micro-system of canals (*loc. cit.*) fed by different streams flowing into the Rio Grande. Each state controlled, as the present-day counterparts do, one or two of these water sources within its territory, and the network of canals which fed from them.

It is not clear why the Cañada state-towns did not use Rio Grande waters for irrigation. In the old fortified site of Quiotepec, the Rio Grande forms steep cliffs and narrows considerably, so that canalization of Rio Grande waters is practically impossible; nevertheless lands below it are irrigated. Canals to irrigate the whole of the Cuicatlan valley from Rio Grande waters would have demanded the construction of a large deviation dam and canals approximately 17-20 kms. south of the settlement boundaries, passing through territory belonging to other cacicazgos. This would have required the agreement and cooperation, and possibly the consolidation of leadership, of more than one señorío. But minor, local canals using Rio Grande water are, and were, possible to build for short stretches *within* the cacicazgo boundaries. These canals can water approximately one-third of the width of the Rio Grande alluvial valley. Two new canal systems at the present time follow this pattern.

Why protohistoric Cuicatlan preferred as a culturally viable solution the use of only stream waters, rather than a combination of Rio Grande and stream, as it does today and as Atlatlauca did in pre-Hispanic times, can probably be attributed either to technological difficulties in using Rio Grande water, or to a lack of need to increase the supply. Considering the former possibility, the use of Rio Grande water does not seem to be, in our inexpert opinion, much more difficult than the construction of stream canals. A major problem exists, however, which may have produced conditions which led farmers to prefer stream use. First, silting is greater on those canals fed by the Rio Grande. Second, the water is located below the irrigable land along the banks, while stream water is located above. The Rio Grande itself has few and widely separated small alluvial plains, and local informants agree that it is rare in a man's lifetime that the river overflows the banks. The affluent streams, however, form, near the confluence, highly productive, although small, alluvial flood plains. Thus, the combination of the technological difficulties of silting and earth removal for canal building (and lack of techniques for lifting water) and the higher production of the stream banks, could have resulted in the exclusive use of stream waters.

Today, surface-fed fountains rather than well water is used in Cuicatlan. No techniques such as "bucket irrigation" are regularly used, except by one individual who comes from the valley of Oaxaca. He carries water to his trees located a few yards above the highest irrigation ditch. Women, in the house, occasionally water flowering plants, but no major crops are cultivated by carrying water by hand. One man in Cuicatlan also uses a battery-run pump, an emergency technique. He only uses it in the few days in the dry season when he cannot obtain town water, if his fields seem overly dry. Regular use, he claims, ruins the pump because of the mud and accumulation of sand. However, it seems more likely that the community of Cuicatlan had not expanded, in contrast to the possibility of limits preventing its expansion. In the Tehuacan Valley, near the Salado River, where the same difficulties existed, and with the added problem of salinity and travertine content of the water, some of the major rivers were utilized(*PNE*, III: 46-54; IV: 213-231; Woodbury and Neely, this volume; MacNeish 1964*b*). Thus, since neighboring cacicazgos did not find technological barriers to the use of these waters, one could hardly claim that this was the case in Cuicatlan.

We suspect that the stream waters, especially from the Rio Chiquito, were sufficient ca. 1580 to irrigate all the land needed by the population and that therefore there was no need to increase the water supply. That is, there was no population-production pressure ca. 1580 forcing the use of all available land in the immediate Cuicatlan plain through diversion of the Rio Grande. This is supported by the relaciones' remarks that, about 1580, water was abundant in the streams (*PNE*, IV: 187). The advent of sugar cane in Colonial times increasing the need for water resulted in the present developments. The pre-Hispanic Cuicatec also cultivated high water-demand crops. A chicozapote tree, for example, requires at least one watering lasting a whole day, every twenty days, compared with a sugar cane field which requires a watering every eight days. On the other hand Cañada-grown corn only needs five waterings between planting and harvest time, that is, during a period of five or six months. This means that if all of the Cañada floor belonging to Cuicatlan was cultivated, and a major portion dedicated to fruit orchards, as the relaciones imply, stream waters could not have been sufficient. Today, only in the wet season are all the agricultural fields active. In the dry season and even considering that it is not used for sugar cane, the stream still does not provide sufficient water to irrigate, except for the center of the system.

Cultural-ecological factors seem to support either of two views: (a) that all land was cultivated despite water scarcity, an observation which *PNE* contradicts (if all land was not cultivated, it is incomprehensible why Rio Grande waters were not made available); or (b) that the amount of land under cultivation was reduced to the point where the water supply available from the stream could be effectively utilized. It appears that population pressures could not have been very great in the Cañada around Cuicatlan ca. 1580 because we know that, whatever the size of the area under cultivation was, Cuicatlan had "abundant water" and produced a sizable amount of surplus for trade and tribute. Unfortunately, population figures for 1580 are totally misleading because the region had already suffered from a series of epidemics which had killed off an enormous percentage of the population. Tepeucila, for example, which had approximately 100 tributaries or taxpayers in 1579, was claimed to have approximately 2,500 tributaries in 1549, and 40,000, obviously an exaggeration, before the Conquest. In 1580 Cuicatlan had 600 tributaries. If between 1550 and 1580 the proportions noted for Tepeucila were true also of Cuicatlan, it would have had a population of 1,500 tributaries. We believe that if the Postclassic archaeological site proves to be co-terminous with the apparent limits, it is not unreasonable to assume a population of 5,000 during the pre-Conquest sixteenth century. The present town has a population of 2,500. This figure is not relevant here. The town plants cash crops and buys its staples from the Indian hinterland outside the district and therefore subsistence agriculture is of minor significance today. Furthermore, the standard of living has radically changed and so comparisons are ridiculous. Although we believe that probably Cuicatlan could have supported a population of 5,000 and produced a tribute surplus without use of Rio Grande waters, we have no reliable way of demonstrating that this was the case. Only a more detailed archaeological investigation of settlement pattern and land use could provide us with a more reliable answer. At present, we do not know why control and utilization of only streams was their only culturally viable solution, common also in other areas of Mesoamerica. It is possible, however, that before Spanish entry, when population pressures must have been greater, the Rio Grande waters were used for local canal feeders. If this was the case, it may be possible to retrieve some archaeological evidence.

The importance of control of water sources by each of the other states becomes evident by the nature of their affluent streams or creeks, and of the climatic and geological conditions which produce seasonal scarcity (cf. Palerm and Wolf 1961: 272 for a related point).

The scarcity of water is increased by the technology involved in canal building. Water is lost in the canals because they cross sections of terrain in which water absorption is high, and no means of avoiding loss is possible since the canals are not lined. Again, water is lost at the damming points, because of the primitive, flimsy composition of the constructions, easily washed away by increases in water flow. Finally, near the Rio Grande banks, in the Cañada, water is lost by high evaporation in the canals (pers. commun., Papaloapan Commission, Tehuacan). This situation is probably very similar to the pre-Hispanic one, unless archaeological research demonstrates that ditches, sluices, and dams were of more durable and weather-resistant materials. Geological conditions and climatic factors affecting the rivers do not seem to have changed.

Even under conditions of water scarcity, dry climate, primitive technology in canal building, and reduced size of irrigable land area, there is no doubt that in the Cuicatec region "gross amounts of deployable surplus" were available, i.e., for tribute and the support of a non-agriculturally engaged elite (cf. Orans quoted in Adams 1966 for a definition of deployable surplus). Increased irrigation, both in number of waterings per plot and in number of irrigated plots, increased gross per capita surplus. Today, richer men who can build their own canals or bribe water distributors, produce much larger crops than those whose fields are irrigated less often even though location and soil may be identical. In the wake of increased irrigation may follow not only larger production but population growth. We do not have comparative data for sixteenth-century communities located on equivalent areas of land with similar supplies of water, in relation to irrigation works, production, or population size. Our comparative data comes from mountain and Cañada cacicazgos. But ninetenth-century data may be relevant here for intra-Cañada comparisons.

During the first part of the sixteenth century the Spaniards founded a hacienda across the river from Cuicatlan, Güendulain (today Valerio Trujano), which became a separate community. Local tradition asserts that it was founded by the first *encomendero* (corregidor [?] of Cuicatlan (Osorio 1959 unpublished). In 1883, Güendulain had three square leagues of land, and 8,500 varas of aqueducts and canals, built both of *mampostería* (bricks and stone with earth filling) and packed earth. With this irrigation network, Güendulain supported 500 inhabitants. Cuicatlan, across the river, has ecologically identical land watered by a separate stream, of equivalent flow. The territory controlled by Cuicatlan and dependencies was 20 square leagues. These were irrigated by a canal system 12,400 varas in length, also of *mampostería* and packed earth. With this system, Cuicatlan and dependencies supported 1,530 inhabitants (Martinez Gracida 1883).

	Güendulain	*Cuicatlan*
Varas of waterworks per sq. league	2834	620
Density of population per sq. league	167	77
Ratio of canal length per cap. in varas	17	8

Thus, Güendulain with water works 4.6 times longer than Cuicatlan, supported a population 2.2 times larger. Or, expressed in another measure, Güendulain maintained 17 varas per capita of canals, while Cuicatlan maintained 8.1, and under these conditions the former had a density of population 2.2 times higher. These population concentrations may be misleading in part. The second half of the nineteenth century is the time of the hacienda bloom in Mexico, and Güendulain was a hacienda community. Cuicatlan, which was officially the headtown, lived in its shadow, and had lost its weekly market and political control to the hacienda across the river. Political officers were "elected" under the hacienda's aegis, and the major road was moved to pass it. But even with these conditions in mind, the figures suggest that *the size* of the local irrigation system played a noticeable role in the potential of a community to support a given density of population.

At present the situation is reversed. Güendulain aqueducts and canals have been partially abandoned while the Cuicatlan irrigation system has been enlarged by the local sugar mill. Both are officially independent municipios, but population density is higher in Cuicatlan which is also politically dominant. To a certain degree, one can hypothesize, these contrasts must have existed in early Colonial times and before, with Cañada cacicazgos. This, however, is only a tentative interpretation.

Contrasts between irrigated communities in the Cañada and those in the mountain states are well documented for the sixteenth century. Irrigation is more feasible in the Cañada, whereas in the highlands, patches of land which can be irrigated are scarce (cf. *PNE*, IV: 92-93). Population densities are higher today and were higher in the Cañada, and irrigation may be pointed to as the cause because of the higher yields per hectare. For example, corn production is twice as high per hectare under irrigation. About 1560-1580 both Papalo and Tepeucila, in the mountains, had much larger territories than either Cuicatlan or Atlatlauca in the Cañada. Their populations, however, were approximately half those in the Cañada cacicazgos.

Calculations of population densities, using sixteenth-century figures on tributaries, and by whatever calculation method is favored, produce the same contrast. Moreover, tribute extraction by both Aztecs and Spaniards was different in the mountain cacicazgos. The Aztecs seem to have extracted most of the tribute from the Cañada (Barlow 1949: 113-118). The Spaniards, at one point during the sixteenth century, collected 280 *pesos oro* from the town of Cuicatlan, while Tepeucila and Papalo combined tributed only 260 *pesos oro* (Boletín del AGN, XI: 198-243). In the *Suma de Visitas*, also, the canyon cacicazgos are recorded as being taxed at different rates, that is, Cuicatlan 300 pesos annually, Papalo and Tepeucila combined only 174 (see Table 14).

TABLE 14

Ecological Potential, Wealth, and Population Size of Cuicatec Cacicazgos

		Population Size (Tributaries)	Tributes
Canyon cacicazgos (high irrigation potential, smaller territory). Corn production approx. 900-1500 kgm. per hectare.	Atlatlauca	700 (*PNE*, IV: 164) 800 (R. de O.: 68) 1206 (*Suma de Visitas*)	1000 pesos oro, and mantles (AGN) 1131 pesos plus (Libro de Tasaciones: 84-85)
	Cuicatlan	300 (R. de O.: 68) 617 (*Suma de Visitas*)	300 pesos (*Suma de Visitas*) 280 pesos oro (Boletín del AGN, XI (2): 205)
Mountain cacicazgos (low irrigation potential, larger territories). Corn production approx. 400-600 kgm. per hectare.	Papalo	600 (R. de O.: 68) 507 (*Suma de Visitas*)	90 pesos (*Suma de Visitas*) 100 pesos oro (Boletín del AGN, XI (2): 209)
	Tepeucila	100 (*PNE*, IV: 95) 150 (R. de O.; 68) 142 (*Suma de Visitas*)	84 pesos (*Suma de Visitas*) 160 pesos oro (Boletín del AGN, XI (2): 213)

The population sizes in the accompanying table are only approximations and not actual pre-Hispanic densities. First, epidemics had already run through the New World killing off large numbers of native inhabitants. Second, they are based on tributary lists, which are approximations of population realities, and were biased by local Spaniards' personal reports. They strongly suggest, however, that the more intensively-irrigated states, even though they supported a much larger population in a smaller territory, may have been capable of producing a larger gross surplus for their conquerors. Given this situation, it must have been crucial for each state, or even minor settlements, to maintain their access to the largest number of water sources possible even though internal population pressures may not have been high.

Since control of stream water supplies was necessary to maintain or increase production, it was important for Cuicatec settlements to control stream sources and not allow other communities to deviate the waters for their own use. The social and political implications, as well as the economic ones, seem to have been clearly understood by Indian witnesses in the 1562 manuscript of Papalo.

One example of conflict over water source rights appears in the 1562 manuscript. Yepaltepec-Papalo and Quiotepec ca. 1172-1198 had fought a war over watered territories in which Quiotepec lost. Both communities used, as they do now, the same stream, but the source is in Yepaltepec territory. In 1562, a dispute between two caciques involved the inhabitants of these two communities. The Indians of Quiotepec were supporting the cacique Domingo Hernandez of Cacalotepec in his cacicazgo succession claims over Yepaltepec, because this man had offered to give them free access to Yepaltepec waters if they served him as witnesses. Yepaltepec witnesses, however, supported the claim of another cacique who agreed with their right to monopolize the stream. At the time of the *pleito*, the inhabitants of Quiotepec not only had to ask permission to use the water for their irrigated fields, but also had to pay tribute to Yepaltepec for this privilege because Yepaltepec had won the war and "because the water was theirs and came out from their hills" (5) (IPCCS: 32). These two communities today, 405 years later, still are under the same conflict, and the upstream community cuts water supplies in times of stress. Every year the local political authorities sign a contract establishing times and amounts of water consumption. At present (1963-1964), they are engaged in a complicated federal legal suit over water taxation rates. Papalo and Cuicatlan, now sharing water from the Rio Chiquito, also make a yearly agreement about water use. Frequently, in the dry season, both communities through their political leaders engage in legal haggling over their water rights. In general, whenever communities in the Cuicatec district today share water sources, agreements have to be regularly ratified and conflicts constantly ensue because of water shortage.

During the Colonial and early independence periods, a number of cases of "land fights" in the Ex-Distrito actually concerned not land but the control of water sources and invasion of surrounding irrigated territory (AGN, Ramo de Tierras: Vol. 868, Exp. 8; Vol. 1715, Exp. 3; Archivo del Juzgado de Cuicatlan: 1878-92). Other scattered documents show that in early Colonial times this was the situation of the Tehuacan Valley, where water is also scarce and water sources were monopolistically controlled by individual communities (AGN, Ramo de Tierras: Vol. 7, Exp. 352, Exp. 484; Vol. 10, Exp. 102; Gil Huerta and Neely 1967). It is important to note that this was the case in the sixteenth and seventeenth centuries, because, with the reduced populations following epidemics, death by forced labor, etc., if water scarcity was still an important issue, conflict over water resources and the need for institutional controls may have been greater. The same kind of phenomena seems to operate today in the Valley of Mexico, where water is becoming more and more scarce. Mixquic has been engaged for years in a fight with a community across the boundary of the state of México, because the two share a spring with two openings which is the source of their irrigation canals for the chinampas. When one system is flowing the other dries up and so winning their competition is vital for survival. The same situation exists in Teotihuacan (Millon, Hall, and Diaz 1962), Relative water scarcity as a determinant of political friction is not a consideration in many other areas of intensive irrigation. (An exception to this is found today in the state of Arizona.) Waterworks and flood control measures may have been more important social issues in the watered area of the Valley of Mexico around Tenochtitlan, or in the river valleys of China. Our data suggest, however, that the factor of *insufficient* water supply among the Cuicatec may have been an important variable, especially in relation to the unification of settlements into larger political units. This, however, was a cultural variable, rather than a purely ecological one, since the Rio Grande was not properly exploited, at least by one cacicazgo, and there was a relative scarcity only of stream water and not of the total available resources.

It has to be noted that in Spanish documents, water fights appear under the guise of land fights, and communal ownership rights of settlements are discussed as individual rights of caciques. Textual materials based on early oral traditions and context often reveal this subtle but important difference between Spanish interpretation and Indian evidence. In the Papalo-Yepaltepec case, the caciques of Quiotepec and Yepaltepec represented their communities in the conflict, and are called *dueños* (owners). It becomes clear with even cursory reading that the cacique's personal or private rights are not involved on any grounds except rights to succession, tribute, or personal service. Indian witnesses appear to consider these secondary to their own interests. Primarily they are concerned with community access to water, and with documenting such rights. It is only for the sake of Spanish judges and scribes and the cacique's personal interests on the *pleito*, that boundaries which do not involve irrigated lands and cacique's genealogical matters come into the picture. Even this, moreover, appears in relation to a cacique's position as officer or ruler in a witness's community. As will be shown later, ownership was defined by the Cuicatecs in a manner quite different from the Spanish.

In the 1562 manuscript it appears that community or cacicazgo rights to land and waters, and water sources, had to be demonstrated whenever there was a conflict. A community's legitimate rights were traditionally perceived by Indians as demonstrable by documentary proof, in the form of versified oral traditions and written pictorial documents, that the territory containing a water source had been originally settled or populated by ancestors of the present inhabitants, or documentary proof that the ancestors had eliminated other claims by winning a war over competitor señoríos. Originally, codices containing such documented information were kept in the hands of the local aristocracy and tequitlatos, two of whom, at least, could read them and paint them in 1562. These were presented in court as documentary proof. Added to them, Indians were questioned concerning their oral traditions and they presented the original Colonial tasaciones, which they claimed had been based on older, pre-Hispanic traditional rights. The details of information including dates, which they recalled for such traditional rights, leave little doubt that this was the case.

Cuicatec codices served for documenting or legitimizing other rights, e.g., cacicazgo succession, and their contents were multi-purpose (cf. Motolinía 1903: 3; 1941: 5; Robertson 1959; Caso 1960*a*). The Cuicatec codices listed land and water rights, cacique's genealogies, dates of battles and wars, cacique's deaths, marriages of the "royal house," tributaries, etc. (IPCCS: 10, 17, 18, 29, 49, 53, 74 passim; *PNE*, IV: 165) (6). The extant historical codices Fernandez Legal, Porfirio Diaz, Quiotepec-Cuicatlan, and the ritual-calendrical Porfirio Diaz Reverse found in the region seem to be examples of the multiplicity of purpose of such documents. Unfortunately, they have not yet been completely studied. Their similarity to the "Mixtec" codices, however, is noticeable (Caso 1965*a*; Cline 1966; Nicholson 1966). They are also important because they contain information on water-source wars.

In the case of the Papalo estancia of San Lorenzo Yepaltepec, both conditions of legitimization of water control were met. The land had been originally populated by colonists from Papalo, fourteen generations of caciques before 1562. Moreover, Quiotepec had lost its rights to the territory and water source by losing a war at the time they had threatened to encroach on such lands and populate with their own colonists (IPCCS: 32, 40 passim):

The importance of water rights, and not just land, is made clear. Ownership is always defined as being over "lands and waters." Boundary descriptions emphasize water sources, irrigated parcels, and fields, and disregard marginal lands. Moreover, Indians are careful to describe the irrigation canals and the immediately surrounding markers, both natural and man-made (Códice de Quiotepec; IPCCS: 13, 19, 23, 29, 31 passim). (7)

Lands which were not irrigated, dry temporal or *nopalera* fields, became important later on in the seventeenth century (Dahlgren de Jordán 1962). During this part of the Colonial era, nopaleras for cochineal production, an industry which expanded into Cuicatec territories, became prize possessions. Hence, in 1711-1718 the Indians of the cabecera of Papalo were involved in a fight with a Papalo subject (Los Reyes) over the control of nopalera lands (AGN: Ramo de Tierras: Vol. 288, Exp. 3; *Expediente de la Composición de Tierras del Pueblo de Papaloticpac* 1718 unpublished).

Land Use and Settlement Patterns

Despite the absence of proper archaeological research, data for the Cuicatec can be of use in determining old settlement patterns and land use. From the Relaciones del Siglo Dieciseis we have indications on four cacicazgos, Atlatlauca, Cuicatlan, Papalo, and Tepeucila. The 1562 manuscript has provided us with detailed information on one estancia of Papalo, San Lorenzo Yepaltepec, a prime example of pre-Hispanic settlement pattern (see below).

In general, two arrangements of population concentration seem to have existed. Cuicatlan was centralized; that is, it had only one large nucleated settlement (*PNE*, IV: 183). (It also had, however, a small hamlet above the Cañada [*PNE*, IV: 84].) Atlatlauca, Tepeucila, and Papalo had, in addition to the cabeceras, *sujetos* (barrios and estancias) scattered over the land in a semi-circle northeast to east to southeast. All subject settlements within a cacicazgo were located within a day's walk of the headtown (Fig. 75). Those of Atlatlauca, as well as Cuicatlan, were located on the small elevations or along the banks of the Rio Grande.

In 1580 Atlatlauca was nucleated, that is, the houses lined up in some kind of street arrangement (*PNE*, IV: 175). This may have been post-Hispanic; but the archaeological remains of compact household clusters in Cuicatlan seem to us to indicate that the nuclear settled community existed in pre-Hispanic times. The "church" buildings, or temples, had houses attached to them in which priest-students resided (*op. cit.*, 166-167). In Atlatlauca we do not know the location of the temple with respect to the town. In Cuicatlan, however, ceremonial centers were located above the house-sites, on hilltops facing the present-day location (*op cit.*, 185; personal observation of surface remains). Today Indians of the Cuicatec communities take their ceremonial offerings to hilltops, which frequently are archaeological sites, or to limestone caves in the hills above the villages. These are associated with native "deities" related to rain and surface water (see above), and in pre-Hispanic times were burial sites, possibly of the nobility. Some ceremonial sites in caves have also been observed by Weitlaner and Holland (Weitlaner 1955 unpublished; Weitlaner and Holland 1960). This is substantiated by the traditional practice in earlier times of locating habitation sites at lower altitudes than some of the centers of religious worship. These ceremonial nuclei were scattered over the Cuicatec area, but not all temples were of equal importance, for sacrifices were practiced only in some of them (*PNE*, IV: 185). It is probable that pilgrimages to the larger temple took place within the region at certain times in the year. The town of Teotilalpan today receives a large number of visitors for the Fifth Friday of Lent, from a radius of over 30 kms. Cuicatec, Chinantec, Mixtec, and Mazatec travel there, to participate in the special market and religious services of the most important of the town's yearly holidays. Since Teotilalpan derives its name from the Nahuatl word for "sacred lands" or "lands of the temple" (Peñafiel 1885, 1897; Bradomin 1955), it is probable that a large pre-Hispanic center of worship was located in its environs. The adjacent village of Teutila ("land of the Lord"), had a large Dominican church apparently built, according to local lore, to replace a pre-Hispanic temple. This, or another archaeological site in the vicinity, may prove to have been an important ceremonial center. If this was indeed the case, it may be significant that both villages, Teutila and Teotilalpan, are located in an area where four languages were spoken, i.e., Mixtec, Chinantec, Mazatec, and Cuicatec.

The relative importance of the archaeological complex of the Cuicatlan headtown can be evaluated by the presence of at least two "temple" structures with associated burial sites rich in "luxury pottery," gold beads, and chalchihuites, and also a ball court (Fig. 89). We know that some of these tombs were built after Spanish entry because, when the air field was built in the early fifties, glass beads of European origin and necklaces of gold beads made by the lost wax method were collected by the air-field workers from these burials. Surrounding the "ceremonial" sites, in lower *mesas*, remnants of house floors located close together can be seen.

Of all the sites, only Cuicatlan has been surveyed to determine its settlement pattern (Hunt and Armillas, pers. commun.). Alluvial plains around Cuicatlan are frequently broken by hillocks and ridges. The upper reaches of these are out of the range of the present-day irrigation canals, and so far as our survey revealed, there is some surface indication of higher canals in earlier times. The probability of their existence cannot be discounted, and we strongly suspect that a more careful archaeological survey may discover evidence of an earlier, higher feeder canal. The vast majority of the archaeological public buildings and house-sites, as well as heavy pottery refuse, are to be found on these ridges and hillocks above the canals. We estimate that there are about two square kilometers of ancient habitations to be found on an arc formed by the ridges and mounds of Cuicatlan, an area more than twice the size of the present-day town. Contemporaneity of occupation has not of course been definitely proven, but if the various sites were occupied at the same time, this was a very compact nuclear settlement with houses much more densely clustered than they are at the present time. Now orchards and patios are interspersed with the dwellings below the canals. The old settlements had clearly marked boundaries and a population which must have been at least twice, and perhaps four times, as large as the present town. The ancient occupations are densest in the region above the center of present-day Cuicatlan. That is, the house and temple sites extend much farther up the slope than does the present town. This survey information matches the information in the *PNE* that Cuicatlan was built on a *"ladera,"* that is, the sloping side of a hill or hills (*PNE,* IV: 184). The present town also occupies the hill's saddle (Fig. 89).

In the settled towns and hamlets of the Cuicatec, social differentiation according to class was apparent in housing facilities, as it appears today on uncovered burial sites. In Atlatlauca, the aristocracy and caciques had large homes with interior courtyards and roof-terraces, while commoners lived in small huts. The size of the cacique's household (palace?) was apparently related to the fact that part of his administrative staff was attached to and resided permanently in separate courtyards in the compound (*PNE*, IV: 166, 168, 175, 188). Palatial housing has been reported for the elite, but in Cuicatlan, Papalo, and Tepeucila in 1580 most houses of the commoners were small and similar to present-day Indian huts. Two remains of pre-Hispanic house-sites in Cuicatlan accidently uncovered by local people were observed by us. The remains show that pre-Hispanic houses were much larger and contained several rooms around a patio, and were more elegant and solidly built than in 1580. The remnants of large stucco floors and painted columns are still visible.

Below the house sites, in Atlatlauca, Yepaltepec-Papalo, and Cuicatlan, irrigated fields and orchards covered the flat lands bordering streams near the Rio Grande (*op. cit.*, 92, 172-73, 187). The house-sites themselves were also adjacent to the same streams, probably to facilitate the use of water for drinking, cooking, and household chores. The present towns follow the same patterns, except that today orchards are also located in gardens associated with houses in the town itself. In Cuicatlan house-sites with orchards occupy the lower levels where archaeological refuse is rarely found. Pre-Hispanic villagers apparently did not build their homes in the irrigated section, only above it.

San Lorenzo Yepaltepec is the only detailed example of settlement pattern and land and water use which we have from sixteenth-century descriptions, aside from the few comments in the *PNE*. This estancia, today the rancho-agencia of San Lorenzo Papalo in the municipio of Concepción Papalo, was located a few hours walk northwest of the barrio mayor or cabecera. Sometime prior to 1562 the Indians had built a Catholic church in the settlement. In this community, the irrigated parcels were far below the house-sites, near the confluence of the local stream and the Rio Grande. The stream originated within their territory in the hills above in Piedra Blanca. Two main canals were dug just below the house-sites at a point called Rio Verde, one on each side of the stream. They were under Yepaltepec control. One main canal served the Yepaltepec field of Llano Verde (*llanguey*), next to Rio Verde. Two other estancias, San Francisco Llano Tiopa and Cuyulapa, today the rancherías of San Francisco Nogales and Coyula in the municipio of Papalo, shared the same stream and the other main canal, but they did not share their cultivated fields (*chico guilla* and *luo-cuey*) or minor irrigation canals (8; cf. also Note 7). In one of the witness accounts it appears as if Coyula and San Francisco Llano Tiopa were kinds of agricultural fields (*clases de tierras*) rather than estancias. These "fields," however, are cited by the other witnesses as estancias and described as such in the *PNE*. The Spaniards had given them saints' names which means they were human settlements. Today they are geographically and politically separated settlements. The same witnesses indicate that these estancias were governed by one cacique. We believe that there were here three different subject hamlets, each with its own field or fields, rather than separate agricultural spots of the same hamlet. Otherwise, there seems to be no explanation for the saints' names, which were usually associated with a local chapel in a residential site. Moreover, the description of the locations of Cuyulapa and Llano Tiopa seems to indicate that they were territorially separate both from the Yepaltepec hamlet and from the irrigated plots which all controlled and that they had been founded before Yepaltepec (IPCCS: 103). The confusion of the witness account may have emerged because the kinds of fields which each controlled were named (in Nahuatl) with the same name as the hamlets which were their "owners." Their names in Cuicatec, however, were different, and referred to the immediate hills and water streams on which they were located, rather than to the estancia. Even though they were unified under a single local ruler, the fields were controlled by each independently. The other two Yepaltepec fields besides *llanguey* were *lladuchi*-Tecpapanapa (land of the government [?] and *llallama* (fire gorge), irrigated from the same main canal as Coyula. These had seven minor irrigation ditches.

Above the irrigated spots, the land was used for houses, temporal crops, and nopaleras (for cochineal). Still higher above these, in colder country, were the *ocote* or resinous pine woods that were exploited for firewood (IPCCS: 13, 19, 23, 29, 32). (Cf. Notes 7, 8.) Control of the Piedra Blanca spring, and the stream length, was necessary in order to legitimize free use of the waters for irrigation. Friendly cooperating hamlets within the state, like those mentioned above, shared the water of one stream, although each also had other streams to use. Communities downstream outside the cacicazgo, for example Quiotepec, had to pay tribute, or a tax (?), and obtain permission, before they could utilize the same water (*op. cit.*, 32, 40). (Cf. Note 5.)

It appears then, that the pre-Hispanic settlement pattern most prevalent among the Cuicatec was one in which small hamlets were located on spurs, ridges, and flats near and above irrigated agricultural fields, in a territory partially surrounding a larger "urbanized" settlement, or nucleus, major in population size, antiquity, and political might. The mountain states tended towards spreading into more numerous smaller hamlets with lower population densities. Papalo and Tepeucila had at least nine each. In the Cañada, Cuicatlan was centralized and had but one highland hamlet. Atlatlauca had six subject hamlets, most of which were on the opposite mountain flanks of the small valley.

There are several possible explanations for the Cañada-mountain contrast. In the Cañada where the alluvial surface tends to be flat and can be cultivated, traveling to the agricultural fields can be done over long distances within the work day. In other words, it is possible for a farmer to live in a nucleated village and commute daily over a considerable distance to cultivate his plot. In the mountains, with the difficulties of the terrain and the longer distances from the cabecera to the irrigable spots, it is more economical in terms of time and effort to live near the *milpas*.

The contemporary situation closely follows this contrast. Another pressure towards nucleation of settlement in the Cañada, versus the dispersion in the mountain, may be related to the problem of water control. The mountain states controlled the upper reaches of numerous small streams, which join downstream to empty their waters into the Rio Grande. By the times these streams reach the Cañada they have a larger water supply but are lesser in number. It is possible to observe on the map that upland estancias were located adjacent to these small streams and were strategically distributed for water control at points where the feeder canals were opened (Fig. 75). In the Cañada, where water sources are not so numerous, a single settlement near or adjacent to the single major stream would have served to control water for irrigation.

Thus, the Cuicatec territorial and local units were organized in a political center-multiple barrio system, rather than in a dual-division system or in disperse hamlets with vacant ceremonial centers. None of the Cuicatec villages or municipios of today, therefore, are of either of these types as are other Indian communities (some Mixtec, Zapotec, Tzeltal, etc.) of Mexico (Hunt and Nash 1967). Rather, colonization movements in the highlands appear to have fanned out in an eastward direction, so that the political "centers" were the meeting point, and the subject settlements the periphery, of an open fan (Fig. 75). Thus, the dual (or moiety) patterns of territorial arrangements or the vacant ceremonial headtown were by no means the only autochthonous nor even the prevalent pattern in Mesoamerica. The feeling that dual-divisions are "more native" than an arrangement of a nuclear center and a periphery, probably derives from the fact that Spanish post-Conquest towns follow the latter arrangement. This is coincidence of pattern, not diffusion. Settlement patterns probably varied extensively in Mesoamerica because the human occupation of sites was adjusted not simply to social pressures but primarily to ecological conditions.

Land Tenure

None of the Colonial sources discussing the initial periods of contact between the Cuicatec and the Europeans have information directly focused on the topic of Cuicatec land tenure. The 1562 manuscript, however, contains sufficient data to permit us a preliminary interpretation. Since all statements below derive primarily only from this one source, our conclusions may be biased and should be taken as working hypotheses rather than as final analysis.

In the state of Papalo, each settlement controlled its own parcels and fields. Although Yepaltepec, Coyulapa, and Llano Tiopa shared the water of a stream, each controlled its own fields, which were referred to collectively as "the parcels of such and such estancia." These were cultivated only by the local estancia peasants (*moradores*) who resided permanently in the estancia settlement. These peasants were commoners (*Indios naturales; macehuales*) and did not own the land privately, nor did they have permanent usufruct of particular parcels (IPCCS: 13, 28, 36, 38, 40, 81). Each year, the individual peasant was assigned a different plot to cultivate (*loc. cit.* and 18, 53, 61, 63, 67, 71 passim). The task of land redistribution was the primary administrative job of the local ruler, who had the power to make the decisions and oversee the annual redistribution of the land among the peasantry (*loc. cit.*) (9). It was not part of the duties of the local commoner officer of the estancia, the tequitlato, although he was the local administrative assistant of the cacique and kept accounts, taxation lists, etc., for him (Sanders 1965: 28), nor, apparently, could he be assigned this task. This piece of evidence on land redistribution is significant, particularly in the light of previous interpretations which suggested that such systematic mechanisms of land distribution were absent in Mesoamerica, at least for the Aztec (cf. Adams 1956: 88). These previous interpretations also contrast with contemporary Teotihuacan where water rather than land is "redistributed" to equalize opportunity of crop success in different fields (Sanders 1965: 37). We may have to change somewhat our previous analysis for Mesoamerica as a unit, or change some of our research strategies, that is, indulge in a more careful and abundant use of sixteenth-century manuscript documentation on local cases and controlled comparisons, rather than published primary sources.

The ruler, however, did not personally "own" the estancia lands. In one phrasing the estancia is said "to be of the macehuales" and the cacique was to be "in charge of" it (10) (IPCCS: 62). The ruler was assigned service for a parcel adjacent to the macehual common fields, as compensation for his administrative tasks connected to land control (11). Hence, the estancia of Yepaltepec had corporate control of its lands. It is clear from the Papalo manuscript that this arrangement had existed since pre-Hispanic times. That is, the corporate character of estancia land rights was not a feature introduced by the Spanish administration, but was a native, older and pervasive form of land tenure (*op. cit.*, 19, 41, 53, 61, 63, 81 passim).

Barrio or estancia tenure has been preserved in today's territorial arrangements, and, although communal lands are officially controlled by municipios from the head-towns, it is the smaller territorial units (rancherías, municipales, etc.) that are the focus of land control. Thus it is not surprising to find that disputes over land encroachment may occur between a town and one of its dependencies. In the past such conflict ended in political fission or in the emergence of new "municipios." At present the most desirable solution, from the point of view of the dependency, is to become an *ejido*, which takes effective official land control out of the hands of a municipal cabecera and vests it in the traditional land tenure units (Simpson 1937; cf. also Eva Hunt, n.d., and Hunt and Nash 1967). During the sixteenth century dependencies petitioned the government to become *cabeceras* of *cacicazgos*; at the turn of the nineteenth century dependencies petitioned in the Mexican courts to become free municipios; and now they petition the Agrarian Department for ejido grants *on lands which they already control.*

A question remains, however, concerning the rights of caciques or local rulers with respect to land. In the Spanish court documents the cacique appears as "owner of land, water and macehuales" of the estancia. This, in itself, is probably a contradiction, since macehuales in Mexico generally were free commoners, neither land-bound nor human property. The word "*terrasguero*" appears in the document as synonymous to macehual. We know that these could be *mayeques* ("serfs" in Nahuatl), and that they were land bound. The word "*terrasguero*," however, is used only by Spaniards; when an Indian speaks, the word "*macehual*" appears. In 1562 these men were free to migrate from one settlement to another. Several witnesses in the IPCCS had done so. Moreover, Indian witnesses mention that the cacique had assigned himself his own parcel, adjacent to the common agricultural lands. This parcel was tended by the community which assigned workers to cultivate it. This was a "voluntary service," a payment in kind, because the cacique "had as his job to redistribute the lands every year in different parcels for each macehual, without receiving any other payment" (IPCCS: 61, 71, 81 passim, each with similar phrasing) (12). It is also said that receipt of this service was a traditional right from time immemorial, because "the cacique redistributed the *solares* for reasons of lordship and nobility" and not because he owned such *solares*. That is, his control of the land was based on a restricted patrimonial domain, not on private property (Wolf 1966).

Caciques received other privileges besides free work in their assigned fields. They received tribute in clothing, firewood and personal servants, and, before the entry of the Spaniards, such exclusive rights as eating deer meat and cacao or wearing elaborate sandals (Wolf 1959: 6-8, 10 passim; *PNE*, IV: 96, 170, 186) (13). After Spanish entry such exclusive privileges also included the use of a sword, Spanish clothing, and the right to ride a horse

(AGN, Ramo de Indios: Vol. 1, Exp. 30, 47, 162, 279; Vol. 2, Exp. 180, 188; Vol. 3, Exp. 767; Vol. 4, Exp. 525, 560; Vol. 5, Exp. 991; Vol. 6, Exp. 180, 540; Vol. 6 [2 Part], Exp. 1052; *ENE*, VIII: 235, 240).

These privileges were suspended if a cacique moved outside the boundaries of his state to reside in another community (14) and he or she was relieved of his administrative duties. Another cacique took his place, duties and privileges included (IPCCS: 76, 85, 86, 92; AGN, Ramo de Indios: Vol. 2, Exp. 74, 881). It was necessary that a cacique reside in the territory he governed or administered in order to claim political privileges or rights, a feature which seems to be prevalent throughout Mesoamerica. Probably this was the reason for the requirement that Mixtec cacique heirs be raised in the towns or settlements they were expected to inherit, even though their parents may have been residing elsewhere (Caso 1960*a*). Even if a particular ruler was acknowledged by both Indians and Spaniards as legitimate, he could not in 1562, "at any time sell, or rent such lands (of the estancia) or hills to any person of another pueblo, nor lend them" (IPCCS: 36). They could, however, sell water.

Although the cacique was the "legal representative" of the corporate owner (i.e., the community) in the Spanish courts, it does not appear that there was private ownership of estancia lands, by the cacique or by any other person. It seems possible, however, that rulers inherited personally from their parents the rights to control certain fruit orchards (IPCCS: 18, 23 passim). Again, "ownership of huertas and fruit trees" is not clear in its implications. We know macehuales worked them, but we do not know what kinds of transactions occurred in terms of inheritance or redistribution of usufruct rights. The 1562 text gives the vague impression that they were inherited when included under the cacicazgo rights to certain parts of a territory, but they could have been either private property or entailed lands for the usufruct of the present governing ruler of a state. Today, among the Indians, fruit trees are owned separately from the land on which they stand. They can also be sold, rented for picking the fruit, privately inherited, or otherwise disposed of separate from the land. It is possible that this practice was in existence among both Cuicatec nobility and macehuales, or either, at the time of the Conquest. Unfortunately our early sources are mute on this point.

Two possible interpretations of rights of the Cuicatec-Papalo communities and cacique's rights to land are derived from the reliable data on estancia lands and from comparisons with the Aztecs. Yepaltepec seems to have had the equivalent of *Altepetlalli* or *calpulli* lands, i.e., communal lands corporately controlled by a territorial unit and possibly a descent group, within its hamlet or settlement. In his position as administrator, the Cuicatec cacique could have been the counterpart of the Aztec *calpullec*. However, the Cuicatec caciques were true lords and aristocrats of the royal house, not simply commoners or principales. Their patrimonial rights to perform services and their usufruct rights over the parcels were vested in the office. Some of the estancia lands were assigned to the cacique "not as an individual but as a functionary" who administered land. Such parcels for cacique usufruct were probably the equivalent of the Aztec *tecpantlalli*, and were office lands. The equivalent of the *calpullec* more likely was what the 1562 manuscript and *PNE* call the "*tequitlato*" (Carrasco 1961) (see below). There is no evidence that Cuicatec rulers had either private lands or "serfs" to work them (*pilli* lands and *mayeques*) (Caso 1959; Kirchhoff 1954-55). However, this remains as a possibility. During the sixteenth century at least two local rulers of Tutepetongo and Quiotepec claimed, vis-a-vis the Spaniards, "private" ownership of particular plots and orchards (AGN, Ramo de Indios: Vol. 3, Exp. 910, 966; Ramo Mercedes, Vol. 5, Exp. 357).

Even if private rights of ownership of the Papalo-Yepaltepec nobility were not given in land, the situation for the state overlord, either at the capital level, or in other Cuicatec cacicazgos may have been different. It is probable also that temples and religious schools (such as that of Atlatluaca) had assigned agricultural fields, or fields whose products were monopolized for temple use. It is clearly possible that the Cuicatec also had *teopantlalli* lands. Teotilalpan derives its name from the Nahuatl word for "sacred lands or lands of the temple" (*teotlalli, teopantlalli,* or *teotltlalli pan*) (Peñafiel 1885, 1897). Thus it is probable that in this community, which is an important religious center today, or in its environs, were located a temple and its attached lands.

Although the ruler of an estancia administered and redistributed its lands and had a house in the settlement, he did not need to live there as long as he resided within the señorío territory. He could, and in 1562 apparently they did, live in the capital. About 1580 the Atlatlauca cacique and his kinsmen also were said to have lived in their cabecera (*PNE*, IV: 168). In the hamlets themselves lived the lord's local delegates, occupying official posts as administrative assistants. This post was called "*tequitlato*" from the Nahuatl; the present-day Cuicatec translation is *nyandi*, but the Cuicatec word does not appear in the IPCCS. The tequitlato was a "principal," but a commoner (macehual) also (IPCCS: 59, 60 passim). He transmitted and supervised the lord's orders, determined that they had been obeyed, called for communal labor and services ("*tequios*") when ordered by the ruler, and collected the tribute from the peasantry to give to the cacique (*PNE*, IV: 168; IPCCS: 40, 60 passim). In 1562 they were also in charge of some pictorial manuscripts dealing with estancia affairs, and at least two could paint and read them (*loc. cit.*). All this suggests that the *nyandi* was the Cuicatec equivalent of the *calpullec* (Caso 1963: 873). There is no evidence about what kinds of rights in land were assigned to tequitlatos, but we do know that they were local inhabitants of the estancias and so they probably received parcels for cultivation with other macehuales. We do not know if, as among the Aztecs, the posts were inherited or were appointed.

Caso has pointed out that in Mesoamerica it is a mistake to project information relevant for a large city like Tenochtitlan, the "capital of a true state and hub of an empire," to small towns in which social differentiation hardly existed (Caso 1963: 862). It should be kept in mind, hence, that although at present direct evidence is not available, the wealthier, complex cacicazgo headtowns, for example Atlatlauca in the Cañada, probably had developed more complex social organizations than the subject mountain communities such as Yepaltepec, or, in general, were more complex than the poorer, less developed mountain states such as Papalo.

Also, the situation may have been different in Atlatlauca because, as the writer of the relación mentions, there were slaves (*PNE*, IV: 166). These may have been war captives for sacrifice in the temple; at least they appear to be so from the context. But it is also possible that the corregidor was referring to a local equivalent of mayeques. If this latter was the case, caciques of Atlatlauca may have had privately owned lands. This is purely inferential, however, and cannot at the moment be validated.

Thus, in claiming a relatively useful amount of understanding of the land tenure for one mountain cacicazgo, we cannot, in our analysis, necessarily apply it to the whole of the Cuicatec nor to other Cuicatec states in the Cañada. For these, unfortunately, we have no information on land tenure. But a tentative picture has surely emerged, pointing both to similarities with and differences from the Mexica land tenure system. In summary, the Cuicatec had: (a) Communally-owned lands belonging to territorially-bound settlements of commoners. These lands were worked by free peasants on the basis of one year rights of usufruct over particular parcels. After a year the parcels were redistributed among the community members by the ruler-administrator of its local government. (b) Office or government lands. These were plots and orchards attached to each community, and assigned for the cultivation of crops to support a secular, aristocratic ruling class. The class had restricted patrimonial domain over these lands, i.e., successors to ruling officerships "inherited them," but they could not be treated as individual private property for they could not be voluntarily transferred or sold. The planting and care of the crops was done by some of the free, commoner peasants who were assigned by the community each year for the servicing of the government lands, as well as for personal service in the ruler's household. (c) Temple lands, the proceeds of which were for the usufruct of the priesthood and the needs of the Church and Church schools. We do not know who worked these parcels. (d) The evidence leaves a gap vis-avis Aztec land tenure: there is an apparent absence of private property which existed, albeit in incipient distribution, among the Aztec. Matching this evidence, there is an apparent absence of the social class of mayeques, or land-bound serfs, who cultivated the privately owned lands of the Aztec nobility. This seems to point out that the Cuicatec were less developed in their land tenure forms than the Aztec, in all probability due to their provincial position in the folk-urban continuum. That is to say, they were not necessarily creators of new social forms, rather they slowly adopted the developments of larger, dominant cultural centers. Their "backwater," rural position caused them to maintain earlier forms of economic, political, or social arrangements longer than other groups. Furthermore, they had fewer strata in their ranked-class organization, and less distinct wealth cleavages between the top and bottom of the society. This interpretation is reinforced by information on other aspects of the social system.

Relations Between Cuicatec States

Interaction between Cuicatec states, that is señoríos or cacicazgos, was apparently frequent and in many spheres of life. In the economic realm the state was organically specialized. Cuicatlan traded maize and other staples with Papalo when the latter's own corn fields did not produce sufficiently (*PNE*, IV: 93). Tutepetongo in the Cañada bought cotton from Tepeucila (Bernal 1962: 13) and the Tepeucila inhabitants sold their labor to the irrigated communities (*PNE*, IV: 98). Tonaltepec traded with Tepeucila for salt (Bernal 1962: 18). When we consider that Cuicatlan, on the one hand, cultivated successfully with irrigation and that Papalo agriculture, on the other hand, was for the most part temporal, and Tepeucila only temporal, it is not surprising that all were linked in an economic symbiosis. One may ask what other kinds of symbiotic economic dependency, and others in its wake, were formed between the mountain and Cañada cacicazgos because of this difference. That is, to what extent was the Cuicatec area a symbiotic region? Today, the relation is clear: the mountain area, of lesser ecological potential and lower production, has remained Indian; the wealthier Cañada became Mestizo; but both are dependent on each other for survival (cf. Hunt, R. 1968). Politically the Cañada towns dominate. Their monopolistic control of better lands, supply of water for irrigation, control of commerce, administration of justice, and sovereignty in other important domains of life, is hardly questionable, or questioned. The people of Cuicatlan, moreover, claim their town was "capital of the whole Cuicatec State." There is no documentary evidence, however, to support their claim. In all probability this is a myth of the Colonial Period, when Cuicatlan became the Spanish capital of the province.

Intermarriage between inhabitants of different settlements was the common practice among the Cuicatec elite, the caciques and principales. We know that the elite was class endogamous, and thus was forced, at least among cacique families, to be town exogamous (*PNE*, IV: 167; IPCCS passim), since apparently there was only one lordly family per settlement. The Papalo genealogies show, when information is given, all marriages taking place between inhabitants of different settlements or, in other words, between aristocratic lines of different town-states, or estancias, even across language boundaries. We do not know, unfortunately, what the practice among commoners was because we do not have evidence indicating what kind of kinship base the territorial units called estancias or barrios had. There is evidence that some present-day northern Cuicatec have localized ambilateral descent groups which tend to be village endogamous and are old structural blocks, dating at least as far back as the eighteenth century (Hunt, Hunt, and Weitlaner 1968). Ambilateral "clans" (ramages?) were hypothetically present in other groups in Mesoamerica, for example Mexica, Mixtec, Otomie (Monzón 1949; Dahlgren de Jordán 1954; Carrasco 1950). However, we need to be sceptical of a projection of 400 years into the past. It could be possible that the northern Cuicatec of today represent a kinship and descent organization which did not exist in the southern Cuicatec territories, or that they themselves greatly changed after the Conquest. This information, however, suggests the possibility that future research may uncover evidence of the existence of endogamous, territorially localized, ambilateral descent groups, and that the so-called estancias of the Cuicatec were Cuicatec equivalents of the Aztec *calpul* (Monzón 1949). This, at the moment, is mostly hypothetical.

Friendly relations between Cuicatecs of different states were reinforced not only by aristocratic intermarriage but also by the mythology of common descent, transmitted by oral traditions and codices. All the aristocratic houses of the Cuicatec claimed descent from a single line of caciques ("one House"), and recognized each other as kin (*deudos*), originally headed by one mythical ancestor (15). Both mythology and the frequent practice of cacique intermarriage could have served to unify the different micro-states into a loose, kinship-based political net of territorial units. There is no evidence, however, that the Cuicatec had a formal "confederacy," or that all the Cuicatec states were unified under a single ruler. Kinship loyalties of the ruling class and intra-cacicazgo loyalties following kinship links of the nobility promoted fusion. But the same served to promote friction. In two cases known to us, Papalo and Tepeucila, collateral lines may have been political rivals (cf. later discussion). In this sense, "royal kinship" as a basis for the unification of territories, was as poor an instrument of politics as it was among nineteenth-century Europeans. It is important to note, however, that all evidence points to the fact that warfare seems to have taken place only with non-Cuicatecs. In one case of internal territorial friction known to us, between Tepeucila and Papalo, the solution came about through intermarriage in the junior generation of two cacique lines, rather than by warfare. All other cases of conflict involving named towns, settlements, or states involved warfare with non-Cuicatec-speaking towns.

In the realm of ritual, ceremonialism, and organized religion, there was also a division of labor between states of the Cuicatec. The different town temples were dedicated to different gods whose ceremonies were held at different times of the year (*PNE*, IV: 95-96, 166, 185). From the relaciones it is not possible to learn which specific gods were worshiped in which towns, but the contemporary ethnography provides some extremely useful information. Each of the Cuicatec towns of today is dedicated to a different saint of the Catholic roster, and the major fiestas are arranged in such a way that there is very little overlap of the dates of celebration in nearby towns. In fact, dates are arranged in a calendrical chain so that it is possible for a person from any one town to circulate among major fiestas throughout the Cuicatec Indian hinterland and miss only a very few because of calendrical conflicts. This data in itself is obviously not sufficient, since it is perfectly possible and likely that the fiesta calendar was arranged in this rational manner by the Catholic Church. But the fact is clear that many of the saints which are celebrated in specific towns were selected by the Spanish priesthood because they could be easily identified with the god or goddess that occupied the local temple in pre-Hispanic cults. This is true in Middle America in general; for example, the Virgin of Guadalupe Temple in Mexico City. We know this because contemporary Indian mythology and rituals have preserved the evidence for us. The following examples speak for themselves.

The town of Los Santos Reyes Papalo (The Three Wise Men of Papalo or The Three Saintly Kings of Papalo) is dedicated to the Kings who brought baby Jesus presents on the day of Epiphany, which is the sixth of January in the Catholic calendar. The contemporary Indians of Los Reyes, however, believe that there are four major supernatural beings controlling their town (Aragon Coronado 1954 unpublished). One is *xikioci*, the god who created the universe and has no direct dealings with man. The other three are females who are his "auxiliaries": *kuaa*, white goddess of light; *kuolate*, red goddess of fire; and *kuan*, black goddess of the night. These three supernatural beings descended to earth and into this town in ancestral times, and each brought man a "present" sent by the supreme diety. One taught man agriculture, weaving, and pottery making, another cooking and fire-making, and the third gave man a repairing drug or drink (*pulque*?) and taught him to sleep at night in order to renew his strength. Each one, influenced by the god of death, and without permission of *xikioci*, brought man a different sickness, one of which was associated with their colors. To punish the gods for this, *xikioci* converted them into the "three stones of the household fire."

There are several other versions of this myth that are more detailed and episodical than the simple one presented here. However, even this one suggests strongly that the town had, in the past, been dedicated to the three goddesses of the *Mantenimientos* (i.e., sustenance or maintenance) that are described with similar attributes and mythological histories in sixteenth-century ethnographies such as that of Sahagun. Probably the Spaniards decided on the Three Wise Men because they stood in a similar relation to God, also brought ambivalent gifts, and were the right number, even though they were the wrong sex. I do not know of any three saints or martyrs that could have been equally well fitted, and the Three Wise Men appear to be a remarkably apt choice.

In the village of San Andrés Teotilalpan, the major religious festivity is not in celebration of San Andrés, but Lent, and the church image is not of San Andrés but of the penitent Jesus before crucifixion, his coffin and resurrection, the major event occurring on the Fifth Friday of Lent. This moveable feast coincides approximately with the vernal equinox and is believed to mark the beginning of the rainy season and the beginning of planting. Part of the ritual during the fiesta is clearly designed to insure a proper rain; for example, the major colors used on ritual objects are green and blue. The major supernatural being of non-Catholic origin of the Indians of San Andrés today is Rayo (Lightning), a god who controls rain, and who in his attributes is clearly a modern counterpart of Tlaloc, the prehistoric diety.

Other towns either celebrate a major holiday or are named after saints who clearly appear to have as historical antecedents certain pre-Hispanic religious figures. Several of the towns along the banks of the Rio Grande canyon, for example San Juan Bautista Cuicatlan and San Juan Bautista Atlatlauca, are named after Saint John the Baptist. Of all the saints in the Catholic calendar he is the most apt to represent the sacredness of water. The people of the town of Concepción Papalo, dedicated to the Virgin Mary, believe that the town is ruled by, among other dieties, a female supernatural being dressed in blue and green, who lives in the center of a supernatural lagoon and in water holes appearing in the shape of a snake or of a water monster, referred to in Spanish as a *ballena* (whale). Because this female diety is responsible, in Papalo, for keeping water flowing over the surface of the earth, out of springs, and into the town's canals, a clearer indentification with the goddess Chachihuitlicue is difficult to imagine. This evidence supports our opinion that the pre-Hispanic religious cults of each state were organized in an integrated manner involving the priesthood of more than one temple or state in a specialized calendar of rituals and religious festivities dedicated to different gods in their pantheon.

Pilgrimage rituals involving different Cuicatec villages also appear to have pre-Hispanic counterparts. Major known pre-Hispanic ceremonial centers have continued to be centers of peregrination and of large fiestas with annual markets and rituals which clearly have not only Catholic or folk Spanish elements in them, but autochthonous, symbolic elements of pre-Hispanic religion.

It is impossible to say to what extent other aspects of the pre-Hispanic church organization crossed state boundaries. It would be desirable to have more evidence concerning the activities of the priests themselves. Did they move from one temple to another across state lines? Was temple property owned within state boundaries or allocated to temples in different cacicazgos? Our evidence is frustrating for it leaves unanswered a large number of important questions. However, what is known points clearly to a system of organic integration which involved more than the single town-states, and appears to have encompassed the whole of the Cuicatec region and perhaps even a larger area.

In conclusion then, we see the Cuicatec region in the early sixteenth century as one incipiently integrated into an organic system of exchanges of economic products and labor, in ceremonial specialization, and in the control of internal warfare. Lowland and highland towns were specialized in production and trade, labor services, and ritual. All of them together maintained not only a tradition of common ancestry, but friendly relations and internal peace as well, ratified by marriage exchanges of the local rulers and maintaining throughout time a system of symbiotic dependencies. These, however, do not appear to have led, up to the time of the Conquest, to the creation of a single state system, but rather to the integration of small independent states into a symbiotic social network.

Relations With the Outside World

Wars and Conquest

The Cuicatec states had antagonistic relations with cacicazgos to the south and southwest. Atlatlauca had had wars with the Zapotec towns, Ixtepexi and Tecuicuilco (*PNE*, IV: 169; Spores 1965: 974-976). Burgoa reports that the Cuicatec had had wars with the Mixtecs of the Almoloyas settlements to the southwest (see Fig. 74). The country of the Almoloyas settlement (today Sta. María Almoloyas, Distrito of Nochistlan) was arid and poorly watered, and the inhabitants were attracted by the fertile irrigated lands of the Cuicatec down in the Cañada. As subject tributaries of the Mixtec cacicazgo of Yanhuitlan, they obtained military support in their attempts to conquer the Cuicatec near them, prior to Aztec or Spanish entry (Burgoa 1674: 386-387, 393; Gay 1881, Vol. I: 94, 150, 230, 385, apparently reworks from Burgoa; Garcia Granados 1935 and Jiménez Moreno and Higuera 1940 follow Gay). Secondary sources of local origin (Ladron de Guevara, in Martinez Gracida 1883) indicate that the Almoloyas had conquered the Cuicatec territories to the Mazatec border, in the north. There they founded a pueblo named San Juan Coatzospan (see Fig. 74) but did not move farther north because of their fear of the Aztecs who frequently engaged them in warfare. This information contradicts the claims of the Cuicatec relaciones which only acknowledge the conquest by the last Mexica king, Moctezuma II (*PNE*, IV: 90, 94, 165-166, 169, 185-186). In general, the *PNE* are more reliable than later sources. For example, Gay contradicts himself, once stating that the Cuicatec were independent, and once that they were subjects of Almoloyas (1881: 94, 230). But Ladron de Guevara, the originator of this statement, was a *Jefe Politico* of Cuicatlan (ca. 1883) who claimed descent from the caciques of Quiotepec and Cuicatlan at the time of the Conquest. He was the owner of a "Cuicatec" codex (Fernandez Leal Codex) around 1880 and possessed an extensive Spanish manuscript on the Cuicatec cacicazgo of Cuicatlan which has not been available to us. It is possible that the Codice Martinez Gracida or Cuicatlan-Quiotepec was part of this document, and was given to Gracida as a present by Guevara who was his personal friend, business partner, and political client. The rest of the document was a voluminous Spanish text on European paper and in faded brown ink. It apparently dealt with cacicazgo succession rights and landed property of the Monjaras family from whom Guevara claimed descent and who had been the last cacique line of Quiotepec. This manuscript was inspected by Weitlaner and myself in 1955 for only a few minutes when it was in the possession of Guadalupe Guevara, an elderly daughter of the then deceased Don Benjamin Guevara. The frontispiece was dated 1555 and illustrated in the European manner of cursive writing-drawing with native illustrations of names and calendar dates, showing an elaborate genealogical tree of the Monjaras family. It told of baptism of a Monjaras cacique by Cortez, on top of the hill of Quiotepec. In the same year, C. Martinez Marin, acting on our suggestion, tried to microfilm the document for the National Museum, but without success since Guevara's daughter apparently feared being dispossessed of the original. In our field work in 1963-1964 we were informed that Doña Guadalupe had moved to Mexicali, taking with her all family papers.

It is possible that Guevara had some unpublished information from this document before him. Burgoa, however, indicates only the domination of minor Cuicatec estancias adjacent to the Almoloyas, in the river basin of the southernmost cacicazgo (1674: 387). Our evaluation of all available information leads us to believe that the Almoloyas "conquest" did not involve true political subordination but may have consisted of either frequent raiding parties into the Cuicatec settlements of the Cañada, or the regular, but minor extraction of food-tribute from the Cuicatec settlements in the immediate vicinity of Atlatlauca. Tutepetongo and Tonaltepec, however, may have been subjects by conquest of Mixtec Guautla, although wars are not mentioned (Bernal 1962). In later times, i.e., just before the Conquest, Guautla was a small Aztec garrison tributary to the major center of Coixtlahuaca.

San Andrés Teotilalpan had had a war with Chinantecs of Tlacoatzintepec (Weitlaner and Castro G. 1954). Atlatlauca also had wars with two allied Zapotec states to the southeast, Ixtepexi and Tecuicuilco, located in the Etla-Oaxaca Valley, near the source of the Rio Grande (*PNE*, IV: 9-23 [with map]; 169). Tlacoatzintepec did not practice irrigation because it is located in the rainy tropical side of the District; Almoloyas, for lack of water sources. Ixtepexi and Tecuicuilco had water shortages probably because the Rio Grande runs in a narrow canyon below the plateau on which they are located (*op. cit.*, 19-20). Apparently the wars were unsuccessful, and Atlatlauca remained free.

At the time of the Spanish Conquest, the Cuicatec were not totally independent but paid tribute to the Mexica-Colhua who had invaded them. The Cuicatec claimed to the Spaniards that this conquest had not taken place until the time of Moctezuma II (1502-1520), approximately between ten and twenty years before Spanish entry (*PNE*, IV: 95, 165, 185-186). Guevara, again probably working from unpublished sources (Martinez Gracida 1883), states that the first Aztec conquest had taken place during the reign of Ahuizotl. The *Anales de Cuauhtitlan* and the *Anales de Tlatelolco* (1948: 17-18) also suggest the same. This would push conquest dates back to sometime between 1486 and 1502 (Berlin and Barlow 1948: 82; Jiménez Moreno 1953-56). However, a third possibility exists: some of the Cuicatec may have been partially dominated by the Mixtec of Almoloyas-Yanhuitlan, and since the Aztecs had entered this region sometime between 1481 and 1486 during the reign of Tizoc, some of the Cuicatec settlements may have been, at that earlier date, indirectly involved in a tribute chain Cuicatec-Almoloyas-Yanhuitlan-Mexica-Colhua (cf. the *Anales* of Cuauhtitlan, *op. cit.*, 80-81). Some of the Cuicatec may have been partially dependent or subject to other groups during part of the fifteenth century, in a minor way. Direct political-tributary domination of all states, however, did not seem to have taken place until the last of the pre-Hispanic kings of the Aztec.

Subjection to the Mexica-Colhua during Moctezuma II's reign was primarily for tribute purposes. Teutila was dependent on Tuxtepec (Barlow 1949: 113-118). Cuicatlan, Tepeucila, Papalo, Tutepetongo, and Tonaltepec were tributary to a Coixtlahuaca province garrison either in the Mixtec highlands to the west (Guautla?) or in Teotitlan, which was a Mexica ally (*loc. cit.*, and p. 90; *PNE*, IV: 90, 95, 165-169, 185-186; Codex Mendocino, folios 43r, 46s; Bernal 1962). The Aztecs, following their traditional course, apparently did not occupy the Cuicatec communities or settle their own men, but rather established garrisons in Teutila, in the enemy Chinantec frontier, in Mixtec Guautla, and in Teotitlan del Camino (Espinosa 1910 [1934 ed.]: 386-387; *PNE*, IV, *loc. cit.*, 216; Garcia Granados 1935). They enforced local peace, but left the Cuicatec political leaders to

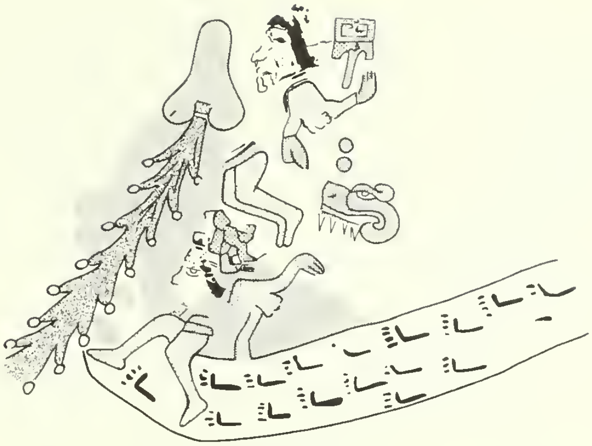


Fig. 92. Warfare over a water spring. Codex Porfirio Diaz, Lámina T.

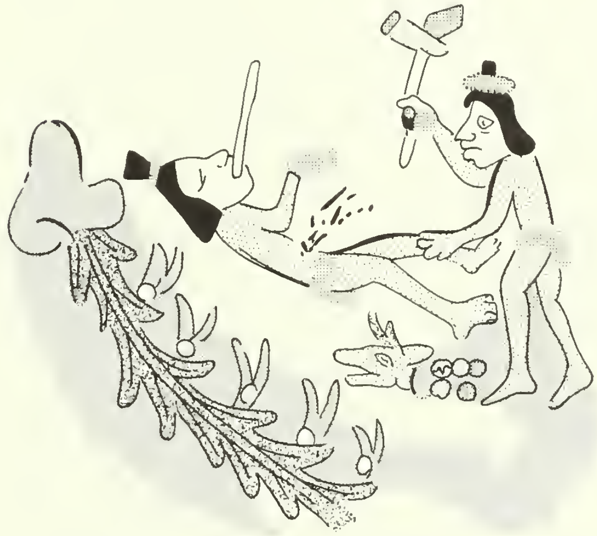


Fig. 93. Warfare over a water spring. Codex Porfirio Diaz, Lámina R.

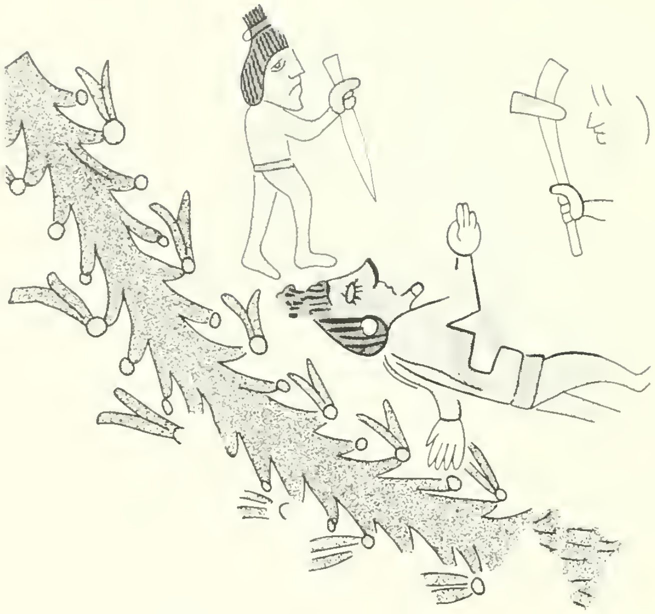


Fig. 94. Warfare at a river location. Codex Fernandez Leal, Lámina XII Reverso.

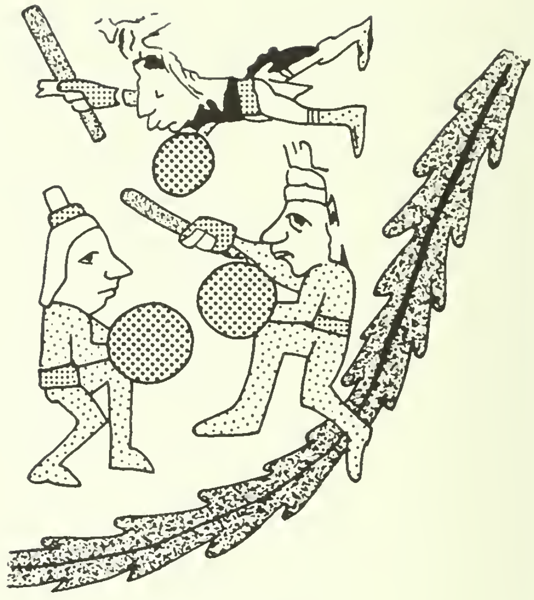


Fig. 95. Warfare at a river location. Codex Porfirio Diaz, Lámina C.

govern and to collect the tribute for them, later sent to the garrisons nearby, and they did not interfere with local arrangements (*PNE*, IV: 166). Thus, for the purposes of internal politics, the Cuicatec states had remained relatively independent until Spanish entry.

Warfare between other local states and Cuicatecs was common before the Aztec conquest; it served to obtain sacrificial victims and tribute, as defense against colonizers who encroached on their fallow lands, to protect local control of a territory, and political autonomy, and to defend irrigated improved lands from invasion by other groups (*PNE*, IV: 96, 166, 186; IPCCS: 12, 14, 32, 40 passim). In wars among the Mixtec, Dahlgren (1954: XII) distinguishes among political, economic, and religious purposes. This diversification of purpose, however, seems to be an a posteriori reconstruction rather than "causes" of the wars. Among the Cuicatec known wars seem best explained (except for "florid wars" to obtain sacrificial victims) as produced by a combination of factors. We have isolated the variables which relate to our theory, but what we call "water-wars" were obviously armed conflicts which involved attempts at colonization, political domination, tribute extraction, and so on, simultaneously. Versified oral history or *versos y cantares* and pictorial manuscripts recorded those pre-Aztec wars (16). The Porfirio Diaz and Fernandez Leal codices, as well as the Tlacoatzintepec Codex, are representative of pictorial manuscripts recording such wars. In the IPCCS, witnesses often refer to the Papalo-Quiotepec war as recorded in a codex from which they are reading, or from which they have memorized their knowledge. These must have looked very much like the two extant Cuicatec and the Chinantec codices mentioned. Waterworks, major rivers and streams, and water sources are recorded with their names in these codices. On the site of water sources, streams, canals, and terraces, the warriors attack, fight, and die, their arrows falling in the water, their wounded bodies spread around it. Porfirio Diaz folios T and R, especially, and also B and C Recto, include such native illustrations. In the Fernandez Leal, Folios IV Recto and VI and VII Reverso are pertinent to water-wars.

Cuicatec irrigation played a major role in determining its relations with the outside world, including warfare. Wars were precipitated by other ethnic groups in adjacent states where the territory did not offer the environment necessary for irrigated agriculture. One of the main objectives was to obtain food tribute from the Cuicatec, or rather, from the successful productive activities of the Cuicatec (Burgoa 1674: 386-387, 393). Other groups attempted to populate Cuicatec lands where irrigation was possible. The Almoloyas, Ixtepexi and Tecuicuilco wars discussed above are examples of the former objective of gaining tribute in food. For the latter objective, we know that, at least 350 years before the Spanish Conquest, the Cuicatec of Papalo had been engaged in defensive warfare with the Mazatec of Quiotepec, "who wanted to populate and take their lands and water." (IPCCS: 12, 14, 22, 32 passim. The best account is to be found on p. 103.) This information suggests that irrigation centers of Mesoamerica, other than the Valley of Mexico, may often have been subjected to the expansive ambitions of ethnic groups that lived in less favored habitats. Given the general ecology of highland Mesoamerica, and the scanty distribution of well-watered territories sufficiently fertile, flat, or propitious for the introduction of irrigated agriculture, it is not surprising that warfare between irrigated and non-irrigated centers was frequent and that associated settlements by "military colonists were established in newly conquered marches to defend the frontier" (Armillas 1964: 324). Frequent invasions or population movements into the Valley of Mexico from the drier, semi-arid northern regions are well documented (Dibble 1951; Wolf 1959: chap. VI). For the Cuicatec, we have at least one instance in which such colonizing activities took place in frontier territory, three in which invasions and conquest were attempted by other groups, and one in which the Cuicatec attempted to encroach on other group lands.

As we have mentioned, the estancia of Yepaltepec, in the Cuicatec cacicazgo of Papalo, had been founded at the time of the war with Quiotepec. Settlers from another Papalo estancia, Cacalotepec, were relocated under the cacique's order and leadership, to protect the Quiotepec-Papalo frontier. Yepaltepec had two sister estancias, Cuyulapa and Llano Tiopa, all under the same local lord. Looking at the map (Fig. 75) it becomes clear that the three were located in a frontier arc, strategically closing off access to the springs which irrigated their lands, and which they controlled. The archaeological site of Quiotepec itself, clearly a fortified site, is also located strategically, in the confluence of the Rio Salado and Rio Grande, closing off the irrigable lands south of it. The buildings face towards Tecomavaca, and are placed on the edge of a steep cliff above a narrow constriction in the canyon. It seems highly likely that its frontier location vis-a-vis other ethnic groups was defensive. If, as Caso and Bernal believe, Quiotepec dates from ca. A.D. 600, and if its strategically defensive position was related to the protection of the irrigated niches below it, the Cañada irrigation dates *at least* from the Classic Period, or the period of Monte Alban as a strong state. We suspect that the technique must have entered much earlier (Late Formative?) into the region, to justify the building of such a large complex site in an inhospitable and otherwise non-productive location. In earlier times Quiotepec apparently was an enemy of the Chichimeca to the north (Chochopopoloca?) ruled by Tlamaca Xicotenantli and his wife "Papalo." Their "child" (son) Nequametl had been imprisoned there after a war and stripped of all his luxury clothing, probably symbols of his social position (Kirchhoff 1947: LXI-LXXVIII, 72-75). Since Chichimeca had conquered the towns north of Quiotepec, that is, Tecolotlan (Los Cues), Teotitlan, and Mazatlan, apparently the northern border of the Cuicatec district was the boundary of their migration or attempts at political domination, and the town of Quiotepec was involved in repulsing their further movement southward. After the war with Papalo the population of Quiotepec moved to the other side of the river.

One could argue then that the importance of the military among the Cuicatec, and the military role of political leaders (cf. also the Relación de Atlatlauca), may have been related to the need to defend irrigable territories. For the Postclassic Mesoamerican periods, imperialistic and expansive, rather than defensive, warfare of the populations of larger irrigated centers (e.g., Tenochtitlan) was most common, at least on the part of some of the states in the Valley of Mexico. But in earlier periods in the Valley of Mexico and Hidalgo, and later periods for smaller less powerful irrigation centers located in marginal or provincial areas, we feel that local warfare must have been primarily defensive in nature and connected with the political economy of water and irrigated agriculture. In this context the caciques' role as local military leaders was an important source of their power. This, at least, seems to have been the case among the Cuicatec ca. 1300-1560. The military role of Cuicatec political leaders was obviously related to the protection of their irrigated territory. Another hypothesis suggests itself here. One of the characteristics of Mesoamerica at the time of the Conquest was the proliferation of small distinct ethnic groups, minor "kingdoms" or states with centripetal orientation, especially in centers of irrigation. In pre-Hispanic periods this fragmentation in the political realm may have been related to the scarcity and location of surface water and irrigable lands in small niches. This may have encouraged the emergence of politically restricted population centers around each of these water sources and micro-irrigation systems (cf. Kirchhoff 1947: LVI-LVIX). Hence there were numerous distinct states of small ethnic groups, concentrated in the areas in which local intensive irrigation was possible, each desiring political autonomy and developing its own, characteristic, semi-isolated sub-culture.

This hypothesis needs to be checked, of course, for other areas outside the Cuicatec; but for them, from the extant data, it seems to be the most logical interpretation of the local situation. The socio-geographical isolation of the Cuicatec with respect to other ethnic clusters, their distinct linguistic character, the autonomy of their political system, and their defensive warfare involving the protection of irrigated lands, all seem to point in this direction. Moreover, it does not seem accidental that friendly relations of the Cuicatec in the sixteenth century were with groups located in the Tehuacan Valley which also had intensive irrigated agriculture, while antagonisms developed with groups that did not practice irrigation, or that desired to obtain control of Cuicatec water sources. An exception is Malinaltepec which chose to ally itself with Atlatlauca against Yolox.

Wars with designated settlements never involve Cuicatec-speaking settlements, but only communities of speakers of other languages; for example, Chinantecs of Yolox and Tlacuatzintepec, Mixtecs of Almoloyas, Zapotecs of Ixtepexi and Tecuicuilco, Mazatecs of Quiotepec (*PNE*, IV: 90, 169, 186; IPCCS: 12, 22 passim; Burgoa 1674: 386-387, 393). This strongly suggests that the Cuicatec town-states as a group were more than just speakers of the same language, but were economically and politically allied, while their enemies were speakers of other languages and attached to cacicazgos of other ethnic groups. This interpretation is supported by our evidence on internal trade and cacique intermarriages within the Cuicatec state, and suggests that the solution of internal territorial conflicts between Cuicatec states was by peaceful means, and that the political elite of the Cuicatec formed a single macro-descent group. Geographical, political, and social insularity of the mass of the peasantry may also have facilitated linguistic drift and variation from related groups which spoke languages of the same family.

External Trade

The Cuicatec, however, had friendly interactions with groups outside their territory to the north and northeast of the Cañada, and traded with both regions. Atlatlauca, Papalo, and Cuicatlan traded with Coxcatlan in the Teotitlan del Camino region to the north for salt (*PNE*, IV: 93, 175, 188). Coxcatlan and Cuicatlan provided the travelling traders or middlemen. Although one Cuicatec cacicazgo, Tepeucila, had a salt mine within its territory, it was not the only source of the product, and by 1580 the mine had collapsed (*PNE*, IV: 98). Atlatlauca also traded their locally made mantles for green beads (*op. cit.*, 117). The Cuicatec obtained cotton in trade with the Papaloapan lowlands which they used to weave clothing, and mantles used as tribute and "money" for trade exchange (*op. cit.*, 93, 98, 165, 175, 185, 188). Today salt is still traded with Coxcatlan among Indians. Cotton for weaving, although usually bought commercially, is also obtained raw from the Veracruz area through Chinantec traders. Cuicatec Indians today still regularly visit the Tehuacan Valley and Veracruz for seasonal work. They also make annual pilgrimages to the important pre-Hispanic religious center of Otatitlan, in the Papaloapan lowlands. Possibly archaeological investigations will produce evidence of prehistoric contact between these areas.

We do not know how the items exchanged in every case, except for small cotton mantles or napkins which may have functioned locally, as an "all purpose money" (Dalton 1965) (17). These were used in some of the Indian villages until the twentieth century! Some of the products such as cochineal, feathers, gold dust, chalchihuites and tiger skins figure among those listed as tribute to the Aztec and may have been used for exchange (*PNE*, IV: 95, 165; Barlow 1949: 117). For the Aztecs, however, they also provided army recruits in times of war, musicians for the Tenochtitlan court, and food and fruit for the garrisons. Barlow suggests that the last two items may have been used to bribe garrison tribute collectors ("*calpisques*") (Barlow 1949: 113). The fruit production of the Cuicatecs was in early Colonial times and is at present one of the major local crops produced in irrigated orchards, and it was traded and sold in local native markets (*tianguis*) (*PNE*, IV: 175). The native fruits such as *chicozapote* and *obos* or native plum cannot be transported long distances, unless by rapid means of transportation, because of bulk and fast ripening, but they can easily be carried short distances on a man's back in nets without spoiling. Modern techniques now allow picking fruit while still green, and artificially ripening it in heated warehouses in Puebla, the night before it is introduced in the market. It is possible, thus, that pre-Hispanic trade involved the exchange of fruit harvest surplus, which was deployable at least part of the year.

Archaeological Evidence of Contact

The Cuicatec region is not well investigated archaeologically. The area is closely related to a "Mixtec tradition" in pottery and architectural styles for the Classic and Postclassic periods. Gray and a few black and red pots and tripods with stamped bottoms and animal-head legs are the most abundant specimens found in surface collections. Weitlaner (pers. commun.) believed they are of the "Coixtlahuaca style." The few published articles, however, indicate that these styles were slightly differentiated, and formed their own minor tradition (Seler 1906, Seler-Sachs 1912; Rickards 1926; Pareyon 1960; Acosta 1965: 835; Bernal 1965*a*: 789, 805-812; Caso 1965*a*: 870). Dating for Quiotepec goes back as far as the period roughly equivalent to Monte Alban IIIB, A.D. 650 (?). Bernal (1965*a*: 789), Acosta (1965: 835), and Weitlaner (1955 unpublished, 1961: 25) suggest the same. The large fortified site at Quiotepec, however, is not necessarily Cuicatec; that is, it may not have been occupied or built by Cuicatec speakers. At the time of the Conquest, Quiotepec was a small settlement below the archaeological site; the large center had apparently been abandoned. None of the early sources consulted by us mentions its existence as an important Postclassic settlement. Tecomavaca and the small settlement-cacicazgo of "new" Quiotepec were, at the time of Spanish entry into the region, Mazatec-occupied, and located within Mazatec territories. In earlier times they may have been dominated by Nonoalca-Chichimeca (?) (Berlin 1947: 73). It is only since the eighteenth century that this area has been occupied by Cuicatecs. Although evidence from Quiotepec may therefore not be relevant to date Cuicatec archaeological remains, it may indicate Chocho-Popoloca, Mazatec, and Mixtec connections. Other archaeological sites of importance are near or under the towns of Coyula, Cuicatlan, Atlatlauca, Chapulapa, Papalo, Agua de la Catrina (near Teutila), and one unnamed site halfway between Cuicatlan and Los Reyes Papalo. All were occupied at the time of the Conquest, with the possible exception of Agua de la Catrina which is located too far north. None have been excavated.

MacNeish (pers. commun.) identified two small bags of sherds from two surface collections on two sites of the town of Cuicatlan. The bulk was probably from the Classic and Postclassic; two pieces were of the Late Formative Period, in his classification. Of the later period, three sherds were identified as belonging to the Tehuacan Valley styles, others as late "Mixtec." The Cuicatecs traded salt with Coxcatlan; they may also have traded pottery, or copied the pottery styles of Coxcatlan. In either case, some influence from the area of the Tehuacan Valley seems evident, and this seems to fit with the other information presented above. The bulk of the pottery, however, seems to be stylistically related to all neighbors to the north, west, and south, to the Valley of Oaxaca, to Coixtlahuaca, and to Teotitlan del Camino.

The archaeological evidence is so meager that little can be said at this time about relations between the Cuicatec region and other areas. It is only in general terms that we can make any sort of statement until further work is done. Although it seems that the region was Cuicatec dominated at the time of the Conquest, and culturally distinct from neighboring groups, evidence from previous times can only indicate that they belonged to a larger, highland regional tradition of pottery making, burial construction, and building styles. Within this tradition (identified as "Mixtec" [?]), they formed their own mildly differentiated archaeological sub-culture. Any connection between archaeological data and human groups, however, awaits future research. We do not feel, at present, that with this scanty evidence we can fit the Cuicatec satisfactorily into a larger scheme of things.

Archaeological research on the origins and nature of Cuicatec irrigation is totally absent except for our own minor surveys. The Mixtec groups to the west and southwest do not appear to have practiced this technique, at least not extensively, at Conquest time, in part because of the lack of usable water. The general dryness of their territory has been remarked upon by the relaciones and all *cronistas*. The Chinantecs did not need it because of moist tropical soils (*PNE*, IV: 50). Irrigation was practiced extensively by the people in the valley of Etla to the south and by the Popoloca, Mazatec, and Nahuatl groups north of the Cuicatec, in the valley of Tehuacan (cf. MacNeish 1964*b*; MacNeish, Nelken-Terner, and Johnson 1967; Woodbury and Neely, this volume; Relaciones of Teotitlan del Camino and Coxcatlan). One site in the Tehuacan Valley includes an extensive dam and canal construction dating back to at least 500 B.C. (MacNeish 1964*b*; Woodbury and Neely, this volume) to the Sta. Maria phase, in the "formative period." Any relationship between the origins of the Tehuacan Valley irrigation systems and that of the Cuicatec needs investigation. It is our hypothesis, however, that irrigation probably diffused from the Tehuacan Valley system to the Cuicatec Cañada. There is no other obvious source, and all other connections point in the same direction. Given the proximity, ease of communication, and similar ecology, diffusion or simultaneous adaptation within a regional oikumenē seems more likely than independent innovation. It is significant here, that all Cuicatec speakers now use the Nahuatl words *apantli* and *chalchihuitl* for the irrigation ditches and dams, rather than a Cuicatec term. In the Relaciones del Siglo Dieciseis, *apantli* is also used, rather than a native word. Irrigation techniques, the use of branch dams, etc., of Tehuacan and Cuicatlan contrast with techniques in the valley of Oaxaca. These, however, may be local adjustments to soils, water levels, terrain, etc., while irrigation as an "idea" may have occurred over most of Mesoamerica simultaneously. Early Colonial and present-day techniques, which show clear continuity, seem to have been the same in both regions, suggesting a common origin. The linked underground wells in Tehuacan are the only major difference, and these are a Spanish introduction and not a native trait. The origin of this technique is Arabic. (Cf. Glick 1970 for a summary discussion of the spread of this culture trait to Spain and to the New World.)

Origin of the Cuicatec State Dynasties

Evidence of the friendly relations that existed between the Cuicatecs and the inhabitants of the northern region of the Teotitlan-Puebla-Tehuacan Valley is reinforced by mythology. The Cuicatec of Papalo claimed descent from immigrants who had entered the region by a route through the valleys of Mexico, Puebla, and Tehuacan, originally from a location near Amecameca (*PNE*, IV: 88). We know this region had a large Mistecoid and "Toltec" population in the early Postclassic and previously (Dalhgren de Jordán 1954: 57-59, 80-86; Jiménez Moreno 1953-56). That is, the Amecameca region was Mixtec or Toltec dominated, on and off until ca. 1350. Linguistic evidence points in the same direction. The Cuicatec language is closely related to Mixtec (Longacre 1957). More recently, Arana Osnaya (1959, 1960) pointed out that the Mixtec elite of Tilaltongo were addressed by a special formal speech, the roots involved being linguistically closer to Cuicatec forms than to informal Mixtec. This may suggest that some Mixteca Alta and Cuicatec noble lineages had emerged or migrated from the same region together as a group, at some point in the past before they split. This is also suggested by the data on the Chichimec-Nonoalca migrations (Berlin 1947: 72-75). As Kirchhoff (1940) pointed out, Chimalpain mentions among the Nonoalca a group of "Poyauhteca or Panohua Yantlaca who establish themselves in Panohuayan-Amaquemecan (the contemporary Panoyan near Amecameca) . . ." (*op. cit.*, 82). The Mixtec had "chiefs who were kinsmen of the Nonoalca" (*op. cit.*, 87), at least according to Motolinía (1903: 9-12).

This traditional information does not necessarily mean that all Cuicatec speakers descended from either Amecameca immigrants or proto-Mixtec speaking peoples to the west and north. It does indicate, however, that the Cuicatec cacique dynasties and the local nobility had originally been a foreign group either proto-Mixtecan or Nonoalca-Chichimeca (?) and had imposed themselves on the native local peasantry in the same manner as did those Mixtec noble lineages who were not originally Mixtecs (?) (Reyes 1593; Dalhgren de Jordán 1954: 51-54, 80-86). Vansina has shown that in African oral traditions migrations often refer to the wanderings and origins of "royal clans" only and not to the bulk of the masses. In oral traditions "the political existence of a chiefdom or kingdom is equated with kingship and therefore the history of the chiefdom or kingship is the history of the people." (Vansina 1967: 60) Oral tradition may also indicate something very different: that the Cuicatec lords had adopted the fashion of claiming descent from groups originating, in the mythical past, from areas dominated by Tula. The custom or tradition of legitimizing political power by claiming descent from Tula lines was extended throughout Mesoamerica. In Colonial times, it was prevalent in the Nahuatl and Popoloca-speaking cacicazgos north of the Cuicatec and among neighboring Mixtecs (see Chap. 4, this volume; Relación de Coxcatlan, etc.). Doing so would have justified the local elite's aristocratic standing in the eyes of the Aztec conquerors, and of the Spaniards too, for the same reasons. We believe, however, that the tradition had real historical roots.

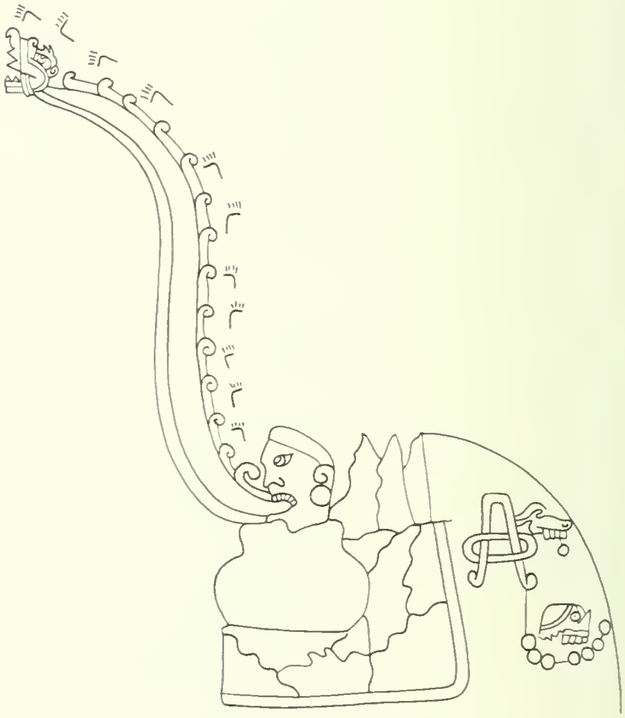


Fig. 96. The symbol of Cuicatlan in the Selden Roll. Caso interprets the glyph meaning as "the head that cries or speaks." If the present interpretation is correct, it means "the head that sings." Burland and Kutscher, 1955; Caso, 1958.

Information from sources other than language and the myths mentioned above points to earlier, pre-Classic (?) Mixtec-Cuicatec relations of a close and amicable nature, and to a common origin of the political elites or "ruling dynasties," even though at Conquest time the socio-political situation was antagonistic. Mixtec myths point to the original development of the Mixtec royal houses or dynasties from populations living or entering into Apoala, a town adjacent to both the Almoloyas and the Cuicatecs, in the Classic Period (Dahlgren de Jordán, *loc. cit.*; Burgoa 1674; I: 274,369; Caso 1958, 1960*b*, 1961; Burland and Kutscher 1955).

In three codices identified as Mixtec in origin, the Baranda, the Lienzo Antonio de León, and the Selden Roll, mythical dates associated with place names of origin of the Mixtec elite lines include a hieroglyph which Caso had identified as "the hill of the head which cries or speaks" (Caso 1958: 382-383). The symbol, a head from which the speech glyph emerges, is located in approximate geographical placing in the Codex Baranda. In the Selden Roll the word or voice symbol appears as a long arc with a serpent head, a water symbol, in the end. In the Lienzo de León this long water-speech arc is ornamented by lateral drawings of succulent xerophites (cactus and *viznagas*) (Figs. 96, 97). Caso does not identify this place name with any particular settlement, but in the Mendocino Codex Cuicatlan is clearly identified in Spanish writing, and is represented by a drawing of a head from which the ornamented speech symbol emerges (Fig. 79). We believe that this indicates that the Mendocino, Baranda, Selden Roll, and Lienzo de León refer to the same place. The vegetation ornaments in the Lienzo de León, and the long water-speech symbol, point to a location near a river surrounded by an arid or semi-arid environment, which perfectly fits the location of Cuicatlan. Moreover, Cuicatlan in Nahuatl means "land of song or singers," which can easily be translated into Caso's "speech or crying" symbol. Furthermore, the Relación de Cuicatlan contains the datum that the name of the cacicazgo had originated from the name of a hill, adjacent to the town of Cuicatlan. In sixteenth-century Spanish orthography of Cuicatec this hill was called *Guetrabaco (sic)* which, according to the *PNE*, also meant "hill of song or singers" (*PNE*, IV: 184). The form probably derives from the Cuicatec words *kaata-bahku* meaning literally "to sing-house," that is "the house of song." Today Cuicatlan is called *Ibahku* (place of houses). The multiple evidence piles up: glyph, name, and language relationships; geographical location and hydrography, and geographical proximity to the mythical place of origin of

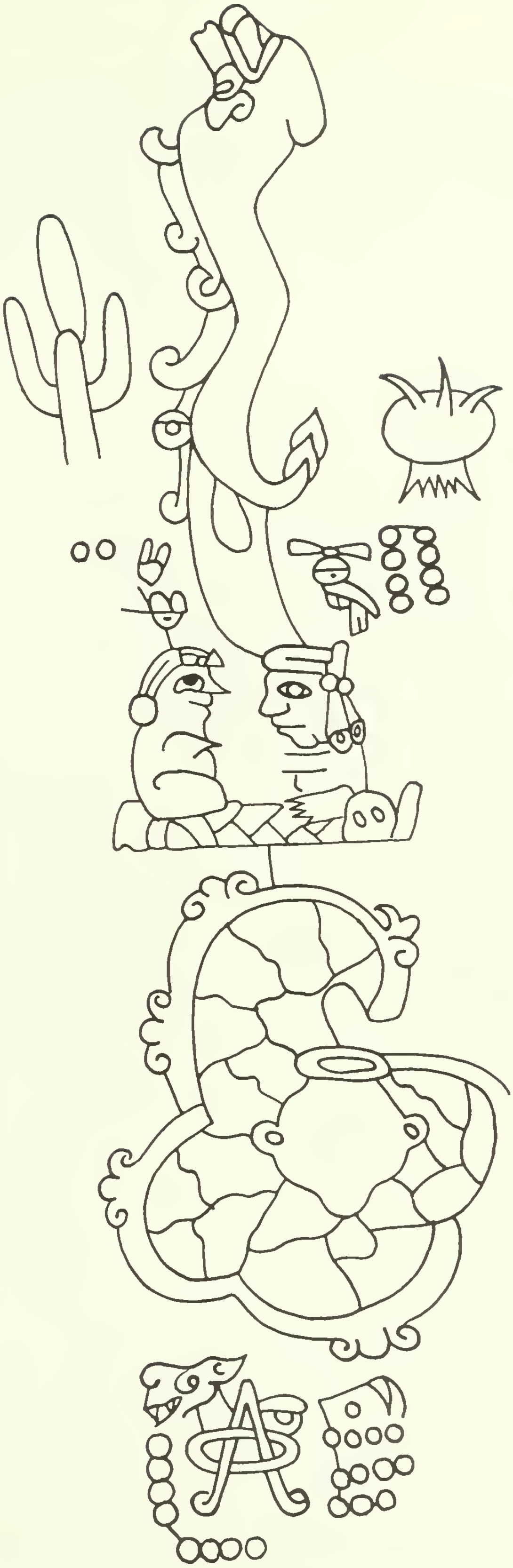
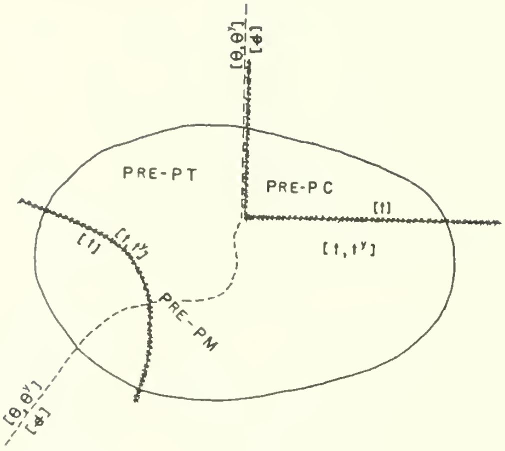
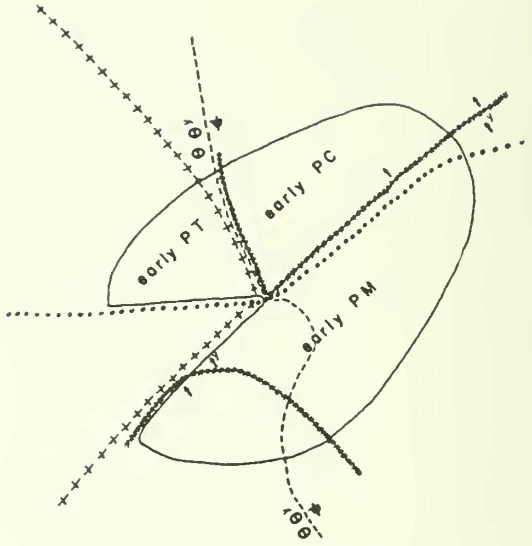


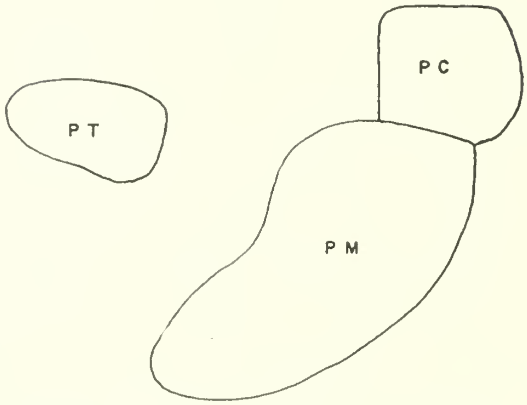
Fig. 97. Glyph of Cuicatlan. Lienzo Antonio de León, Lámina II.



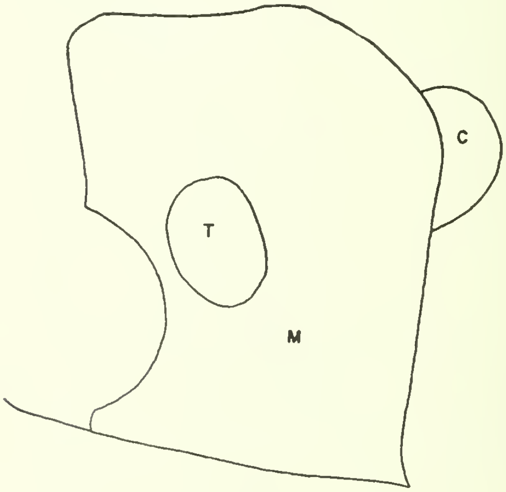
STAGE 1. The late Proto-Mixtecan dialect situation shows no Mixtec-Trique dialect boundary according to the two isoglosses plotted, but delineates Cuicatec from Trique. Line of X's: presence of allophones *[t] and *[t^y] of *t versus presence of only allophone *[t]. Broken line: presence of allophones *[θ] and *[θ^y] of *θ versus presence of allophone *[d].



STAGE 2. Mixtec-Trique isoglosses cease to develop after Trique pulled away from Mixtec. Mixtec-Cuicatec and Cuicatec-Trique isoglosses continue to develop. Line of crosses: separates early Proto-Trique from early Proto-Mixtec and early Proto-Cuicatec which share a common treatment of labials. Line of circles: separates early Proto-Mixtec from early Proto-Cuicatec and early Proto-Trique which share a common treatment of front vowels.



STAGE 3. Effectual contact between Proto-Trique and Proto-Cuicatec is severed. Proto-Cuicatec and Proto-Mixtec are now mutually unintelligible; most further isoglosses developed between the two are lexical. Proto-Cuicatec is pulling off eastward.



STAGE 4. Period of Mixtec expansion results in Trique being engulfed by Mixtec on all sides with consequent cultural domination (late Mixtec loans in Trique). Cuicatec is off to the east but still in contact with Mixtec.

Fig. 98. The separation of Cuicatec from Proto-Mixtec. (After Longacre 1967: 151-152.)

the Mixtec aristocratic lineages; association with dates of origin of Mixtec lineages. All point to a common origin of the Mixtec and Cuicatec elites.

Common origin from within an area of unified influence, at least within a 900-year period (600-1521), and ranging from Apoala to Amecameca at different points in time, is suggested by myth chronologies and codex materials. However, they conflict with linguistic evidence which indicates that the language separation between Cuicatec and Mixtec populations must have taken place long before these dates. According to Swadesh's calculations, the language separation took place approximately 2,500 years before this century (Miranda, Swadesh, and Weitlaner 1960; Arana Osnaya 1960). Jiménez Moreno (1962) reviews the comparative literature of the "Macro-Mixtecan" and "Amusgo-Mixtecana" family of languages. Longacre (1967) without dating it, suggests a similar process of differentiation (Fig. 98). This indicates a geographic distribution comparable to the socio-political one. Our earliest possible date for the origin of some Mixtec noble lineages appears to be A.D. 692, both from codex materials and mythology. For the Cuicatec, our earliest date is 1172. Two explanations of this contradiction are possible.

We know from many anthropological reports that, with non-literate groups, and even among early literate populations, historical spans and information on historical events such as genealogical chains in time, may be "telescoped," or shortened, to maintain a stable number of historico-political sequences which can be easily remembered or adjusted to by the native specialist (Fortes 1953: 27, 31). Thus, one solution to the problem may be that Mixtec and Cuicatec genealogies involving elite origins suffered different telescoping processes, and that actual events were much further removed in time than the historical records lead us to believe.

One other solution presents itself. It is possible that the language differentiation between Mixtec and Cuicatec is older than the development of the two state dynasties. This may indicate that the two local populations became speech-differentiated long before the political elite that dominated both ca. 1520 became linguistically, culturally, or socio-politically distinct. Inter-marriage and common class interests, for which we have evidence, may have kept the ruling groups much less culturally distinct among themselves than either one of them was from the mass of commoner-peasants which they governed. Or, as we have mentioned before, it seems highly probable that Mixtec elites were originally a foreign group, who did not speak Mixtec and who had imposed itself on an older, Mixtec-speaking local population. As the relación of Papalo suggests, this may also have been true of the Cuicatec branch of the elite. This being the case, these sister elites, who may have spoken Yuto-Aztecan, adopted the two different languages of the populations which each had subjugated, languages which had been distinct from each other long before the imposition of a foreign ruling class over a native local peasantry.

Correlation problems between possible Cuicatec dates and other groups are compounded because the Cuicatec had their own distinct calendar (Barlow 1949; Caso 1965*a* and *b*). The codices Fernandez Leal and Porfirio Diaz and the IPCCS contain this information. Their "centuries" were the classical Mesoamerican 52 years (IPCCS: 63, 101 passim) (18). They used the symbol A and O intertwined for the year marker. Robertson (1959) points out that this year notation is characteristic of historic codices. He also makes the same point in Robertson 1964: 433, fn. 17. The agricultural year was 360 days (*PNE*, IV: 166). But the day-year counting was different from the year sequence Calli-Tochtli-Acatl-Tecpatl (House, Rabbit, Cane, and Flintstone) of the Aztec-Mixtec Tonalpohualli (Barlow 1944: 383; Caso 1965*b*: 942, 955-959). We have not yet attempted a correlation analysis of this calendar, a task which requires a high degree of specialization in order to produce any reliable results.

However, dating of Cuicatec cacicazgos from dynastic genealogical data in the IPCCS gives us comparable and more explicit information (Fig. 99). Besides immediate, contemporaneous, and traceable connections among Cuicatec aristocrats or "royalty," caciques claimed a more ancient common origin in a single ancestor. His name has been lost to us. He ruled alone because other lines had been wiped out by an epidemic which took with it all the other living members of the dynasty (IPCCS: 22, 63, 74-75, 80, 91, 103). The witnesses of the Papalo manuscript tell us that at a length of time amounting to ten generations or ten men's lives (or five Mesoamerican "centuries" of fifty-two years according to another reading or witness's version of the same history) removed from this mythical ancestor, both Papalo and Tepeucila had had a single descendant ruler named Citlaltecutli or Citlalteutli (cf. Note 15). The descent lines of the rulers of the Papalo estancias, the Barrio Mayor, and Tepeucila came from either the mythical ancestor, or directly from Citlaltecutli. These, unfortunately, were not completely listed in our manuscript. By 1562 the codex readers and witnesses did not feel it necessary to list the whole genealogy, or they could not recall all the descent links. We have therefore only two complete lines with names going up to Citlaltecutli, and none going beyond him. One is four and the other five generations in length, omitting Citlaltecutli himself, and they do not contain collaterals of the early successors of the state dynasties. Two others are two generations deep. Since the last cacique generation listed in the IPCCS is that of the men in power in 1562, the Cuicatec dynastic lines of ca. 1562 contained either sixteen or fifteen generations since the mythical date of foundation of the reigning dynasty of Yepaltepec-Papalo. If the periods of 10 men's lives or generations and five "centuries" of 52 years, given by different readings of the witnesses in the IPCCS, are made equivalent, each generation was counted as having 26 years. That is, they mechanically reckoned two generations per "century" for dynastic recording. This means that in 1562 the Papalo dynasty had been in existence for approximately between 364 and 390 years, because the caciques immediately following Citlaltecutli reigned ca. 1510. That gives us a date ca. A.D. 1172-1198 for the foundation of the dynasty of the Papalo estancia of San Lorenzo Yepaltepec since it was founded by this first state lord. It also gives us an earlier estimate of 1146-1172 for the date of the foundation of the capital of the state and the estancias of Cacalotepec and Tecomaltianguisco as well as the state of Tepeucila, all of which in the IPCCS are said to have been older than Yepaltepec.

[See Figure 99 facing page 220.]

This dating is, by nature, suggestive but unreliable. First, it is possible that the number of pre-Hispanic generations had been "telescoped." Second, there are no other sources against which they can be checked, except for the last two generations about the time of the Conquest. They appear in the relaciones as well as the IPCCS and the Cuicatlan-Quiotepec Codex. What it does tell, however, is that the Cuicatec ruling houses were in existence at least as far back as the earliest time in which the Chichimecs of Xolotl dominated part of the Valley of Mexico; that is, before the foundation of either Postclassic urban Texcoco or Tenochtitlan. They probably originated at the time of the disintegration of Tula and successive Chichimec migrations (Piña Chan 1960; 93, 95, 103, 104). This dating from the IPCCS, complemented with the relaciones datum that the "first colonists came from a valley adjacent to the mountains of Amecameca," may permit us to tie in the origin of a Cuicatec dynasty and state organization with the general shifts of population, migrations, and social transformations that started with the decadence of Tula and followed the Postclassic growth of Cholula and the movements of the "mixtecoid" groups, such as the *tlailotlaques* (the ones who returned), out of the valleys of Mexico and Puebla (*PNE*, IV: 88; Berlin, 1947; Berlin and Barlow 1948; Jiménez Moreno 1953-56; Piña Chan 1960: 103). Obviously these colonists or rulers, whoever they were, did not enter a no-man's land. Probably chiefdoms of cultivators who did not practice irrigation had occupied the mountain region continuously since the period of early agriculturalists. Before then, small bands of hunters and gatherers must have lived in the lower flanks where prehistoric rock shelters are found today. The social movements following the fall of Tula, however, may be contemporaneous with the appearance of a Cuicatec incipient state organization, based on irrigation and perhaps introduced by a "foreign" ruling group, of higher cultural achievement. A discussion of this hypothesis can be found in our last analytic section but full documentation can only be provided by future archaeological research.

Political Organization and Social Classes

The Cuicatec state territories were governed in the Postclassic Period by an aristocratic elite, which claimed descent from a mythical lordly leader, ancestor of all Cuicatec rulers. All members of this elite considered each other kin (*deudos*), both on the basis of mythical and historical descent and because of immediate kinship connections between contemporaneous descent lines of the dynasties (IPCCS: 22; cf. Note 15). Membership in the elite descent group was acquired exclusively by birth, and required the demonstration of direct or collateral kinship to a line coming down directly from the mythical ancestor in either the father's or the mother's line or both. Among these elite, the supreme rulers for the capitals and the rulers for the subject settlements were recruited from those who could claim more direct linkages in a chain of succession lines rather than in collateral branches (*op. cit.*, 1, 23, 50, 75, 85).

Both headtown and subject settlement rulers were called by the generalized name, "cacique," by the Spaniards. It appears, however, that the Cuicatecs had at least two more subtle distinctions. In Papalo there were two kinds of "caciques." One was a *cacique mayor*, an overlord, who reigned from the capital of a whole state. In the relaciones he appears as *ditonidona* (*sic*), a "Cuicatec" word which the writer of the relación probably misheard or misspelled, and which meant "Great Lord" (Sp: *Gran Señor*) (*PNE*, IV: 90). The other "caciques" were minor rulers who governed over barrios and estancias, i.e., subject settlements. The relaciones do not give the native word for the title of these minor lords.

In the 1562 document, however, males are called *tecuhtli*, lord or magistrate in Nahuatl, and the "*cacica*" of the estancia Teponapa, of Papalo, appears with the Cuicatec title of *Dyille Ebe* (*sic*) attached to her name. We do not have a Cuicatec sixteenth-century vocabulary against which to check this. Alvarado (1593), however, gives the Mixtec cognate word, *yya dzehe*, as equivalent to "Señora," or "Princesa," or "que cria Señores" (female lord; princess; she who gives birth to lords) for the nobility of Tilaltongo. The closest contemporaneous equivalent in Cuicatec is *ii'ya* (Sp: *gentil*; English: noble person). Hence, it is probable that the Cuicatec roster of titles for the nobility was cognate to that of the Mixtec rulers. Mazatecs also used a similar set of cognates, for example in the Codex Ayautla (*hieya*; *nahiya*). In the genealogical listings of 1562 the Cuicatec male caciques appear with Nahuatl calendrical names, to which the particle *-teutli*, *-teeutli*, *-tutli*, or *-eutli* is attached as a suffix. In the Quiotepec Codex the forms *naiye*, *tecuhtli*, and *eihuapili* (female noble) appear. Both kinds of caciques (overlords and minor rulers) received this title. Both were in the line of descent from the "royal house," but the difference appears to be that of senior and junior sibling lines, either in terms of relative age of full siblings or of marriage order of the mothers of half-siblings. Ca. 1562 the cacique of Yepaltepec was great-great-grandson of a senior son who had been ruling head of the whole state of Papalo (Fig. 99). His father, Don Lorenzo Toxtecutli, had succeeded to the cacicazgo, being a son of a first wife. Don Lorenzo's half-brother, Domingo Hernandez, son of a junior wife, was ruler of the estancia of Cacalotepec (a subject of Papalo), but only by virtue of having married the daughter (who herself was successor) of the last cacique possessor of the title before Spanish arrival. While Lorenzo and his son were considered by Indian witnesses as "caciques y *señores naturales*," Domingo Hernandez was only a member of "a minor branch of the nobility" (IPCCS: 50), and ruler *only* by sharing his wife's cacicazgo. Both men, however, were descendants of the *ditonidona Yzteeutli* (Lord Obsidian, Black Lord?), the last Papalo overlord before the Spanish Conquest. Two other half-siblings were, respectively, cacica of Tepeucila and cacique gobernador of the capital (Barrio Mayor) of Papalo. The four, moreover, were connected by affinal links.

Thus, the elite was divided into two distinct parts. One was the "royal house" or reigning dynasty, with both senior and cadet branches, the other was an aristocracy connected to the royal house by kinship and descent (either collaterally or affinally). To the members of the elite who were aristocrats but not of the royal house, the Spaniards gave the name of *principales*, but not of caciques. The Cuicatec words which expressed this distinction have been lost to us. It seems that in other areas the cacique-principal distinction was not operative. But in the Papalo manuscript it seems clear that caciques could be called caciques or principales, and those who were not legitimately rulers by birth could only be called principales; that is, the semantic spaces were not mutually exclusive. It is not clear whether all those whom the Spaniards called principales were members of the aristocracy or whether the term was also used for commoners occupying political posts which the Spaniards had given them. The general rule, however, for the first part of the Colonial Period, was that all major posts (*Gobernador* and *Alcalde Indio* as well as cacique) were only assigned to individuals of the proper aristocratic origin, even if the later procedure for selection or ratification was some kind of election (AGN, Ramo de Indios: Vol. 1, Exp. 162; Vol. 2, Exp. 74, 301; Vol. 3, Exp. 517, 950; Vol. 5, Exp. 917; Vol. 6, Exp. 1182, (Second Part) Exp. 660; Vol. 7, Exp. 285). Two of the Gobernadores of Papalo, Don Francisco de Salinas and Don Miguel Hernandez, had been sent as children to the school of Tlatelolco, "to be trained for office," together with the sons of noble Indians of the Aztec and other ruling houses. Both were lord's sons and at their return became Gobernadores as well as trilingual (Spanish-Nahuatl-Cuicatec) interpreters for the Spanish court (IPCCS: 77, 84). Francisco Salinas was assistant to the writer of the Relación de Cuicatlan (*PNE*, IV: 183).

Recognition of traditional nobility rights was granted by the Spaniards after proper investigation. Those whose claims were validated were given cacique's *tasaciones*, which were generally in agreement, if reduced ("*moderadas*"), with previous tributary rights. These *tasaciones* were granted in accordance with native rules of succession. To the old rights which survived into Colonial times the Spaniards added some newly created privileges, such as mounting a horse, wearing Spanish clothing, or carrying a sword (AGN, Ramo de Indios: Vol. 4, Exp. 525, 560; Vol. 6, Exp. 180, 540; Vol. 7, Exp. 113, 121, 332, 333; Vol. 10, Exp. 42; *ENE*, VIII: 235-240). Moreover, they left in these men's hands a great deal of responsibility in terms of the administration of local affairs.

In general, it can be said that the Indian nobility of the Cuicatecs was easily incorporated by the early Spanish administration into their own bureaucratic system, in part because, previous to Spanish entry, the Cuicatecs had their own incipient civil-military and political bureaucracy, based on traditional patrimonial legitimization (Weber 1947: 341-358). Carrasco has carefully demonstrated how the Colonial and present-day civil-religious hierarchies of Mesoamerica have a background in the bureaucratic organization of the Aztec political, ceremonial, and economic organization (1961). The same general argument can be used, even more specifically delimited in space and time, for the local Cuicatec organization.

In Atlatlauca, the Cuicatec government was organized into three branches, although the spheres of competence were not autonomous. That is, officers did not have "a set of functions rationally delimited in the modern Western sense" (Weber 1947: 344). All of these ruling posts were occupied by members of the aristocratic households. The secular "executive" was composed of an overlord and a "cabinet" or administrative staff made up of a council of elders, and a special consultant ("*ayo*") to the overlord. This body of retainer-kinsmen served as his advisors; they resided in and were maintained by the overlord's household, their habitations being located within a large compound, in adjacent courtyards. Below them were administrative assistants or local managers of particular settlements or barrios, called *tequitatos* or *tequitlatos* (*PNE*, IV: 168).

The "church" or religious branch was headed by priests (*sacerdotes*) who were raised and educated in special schools (*Calmecac* [?]) attached to the temples. These priests were selected by the traditional patrimonial ruler from among the "offspring of caciques and the other principales." Once chosen and ordained, they had quite a bit of power, since they were responsible for cyclical temple festivities to the multiple gods and for oracles, divination, and decision-making on such important matters as initiating wars or approving or vetoing a lord's marriage (*PNE*, IV: 166-167). But their tenure was limited to seven years, and their selection was made by the overlord so that temple affairs were not free from secular control.

The third branch was the military. Army officer posts were also assigned by the overlord. These officers (*capitanes*) were distinguished by special dress or uniforms, and were headed in wartime by an overall war chief who sometimes was selected by the patrimonial ruler and upon occasion was the overlord himself (*PNE*, IV: 169-170). Bravery, however, rather than aristocratic origin, was the crucial factor in selection as an officer (*loc. cit.*). This suggests that social mobility was possible among the military, and social position could result from achievement rather than purely by birth.

The major lord of Atlatlauca is described as a strong autocratic leader (a "Sultan" in Weber's terminology [1947: 347]; a "*Tlatoani*" in Aztec fashion). He had absolute power and was "treated a God" (*PNE*, IV: 166). In Cuicatlan the situation was similar, but caciques did not seem, by 1580, to have commanded anything like the degree of power of Atlatlauca's earlier rulers. The situation in Papalo and Tepeucila by 1562-1580 seems to have been one of lesser social differentiation. The relaciones mention an overlord, who appears in the 1562 manuscript as cacique in the line of descent for two estancia caciques. The Papalo manuscript mentions that there were *señores naturales* (cf. Chamberlain 1939 for a definition of the term), but there is no complete listing of their powers, or exact description of the governmental organization behind them. It seems clear to us, however, from the IPCCS evidence, that the junior sibling lines of overlords were granted lordly rights to rule over minor subject settlements of the cacicazgo, with prebendal privileges, by the cabecera overlord who was a senior line kinsman.

The main differences between Atlatlauca and the highland Cuicatec cacicazgos seems to be in the degree of power assigned to the secular "executive." If the relaciones do not distort past events, the Atlatlauca rulers were fashioned in "Aztec style," while those in the mountain cacicazgos do not seem to have been nearly as absolute in their ability to rule. The major distinction, however, was between the elite by birth, who by definition were able to enter the ruling group, and the rest of the population, who were not: this distinction existed everywhere in the Cuicatec lands. The nobility enjoyed a higher standard of living including housing, clothing, and exclusive rights on luxury items such as some foods. These standards of rank also indicated their monopolistic economic, religious, and political powers, relative to the commoners (*PNE*, IV: 96, 166-169, 175). Differences between Atlatlauca and Cuicatlan on the one hand and the other cacicazgos may be purely the result of accidental phrasing of the sources rather than the actual situation, but it is our opinion that the highland-canyon differences did exist. It does seem clear, nevertheless, that overlords of cabeceras were closer to being true "monarchs" than the caciques who ruled over estancias, who, even though they were of the royal house, were minor political figures.

Below the Indian elite were the majority of peasants, who were free commoners. As noted above, there is no firm evidence that the class of mayeques, or a Cuicatec equivalent class, existed among them. Social differentiation within this class existed between the tequitato or tequitlato, who was an administrative assistant of the cacique, a kind of "foreman" or local steward who re-

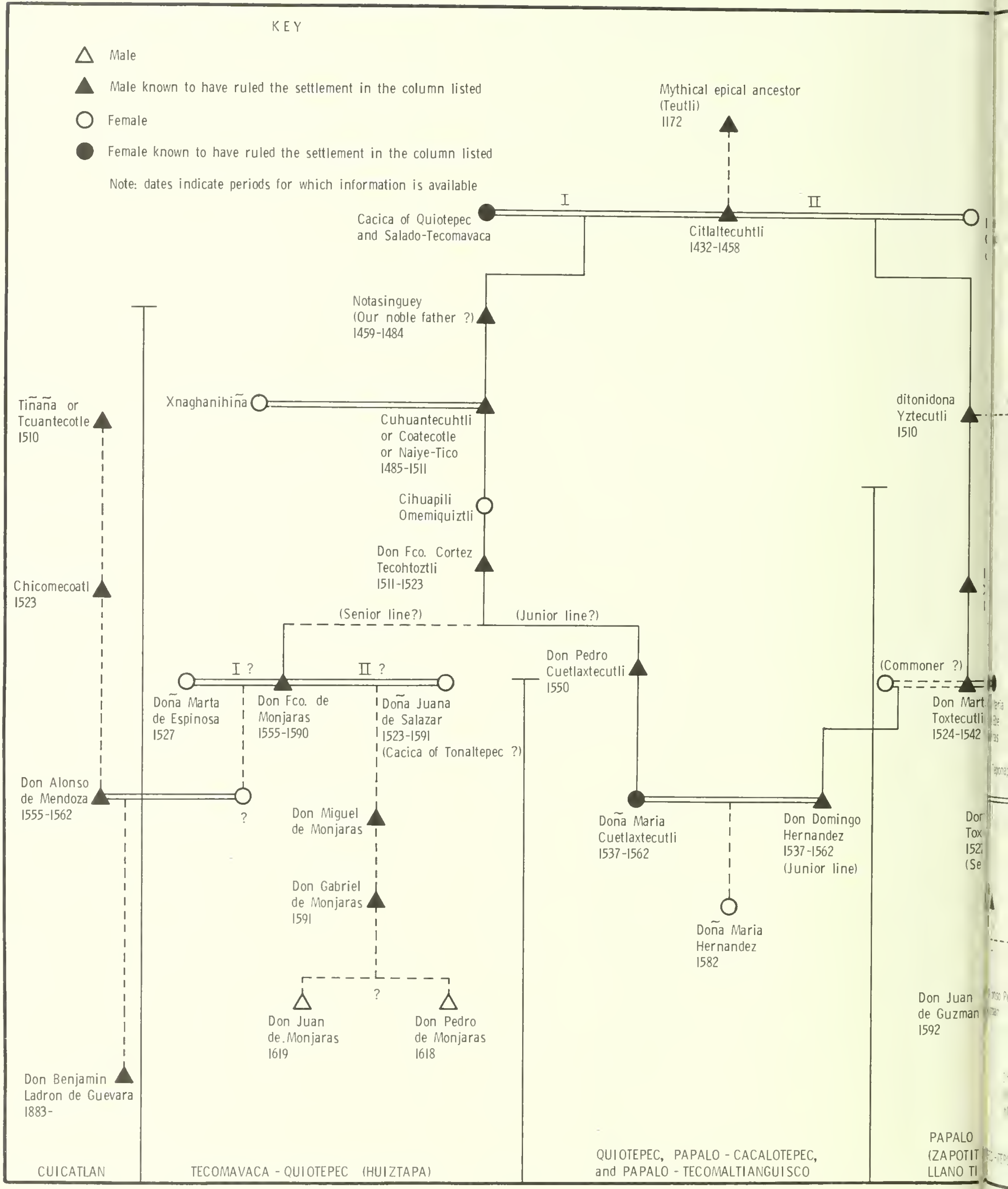
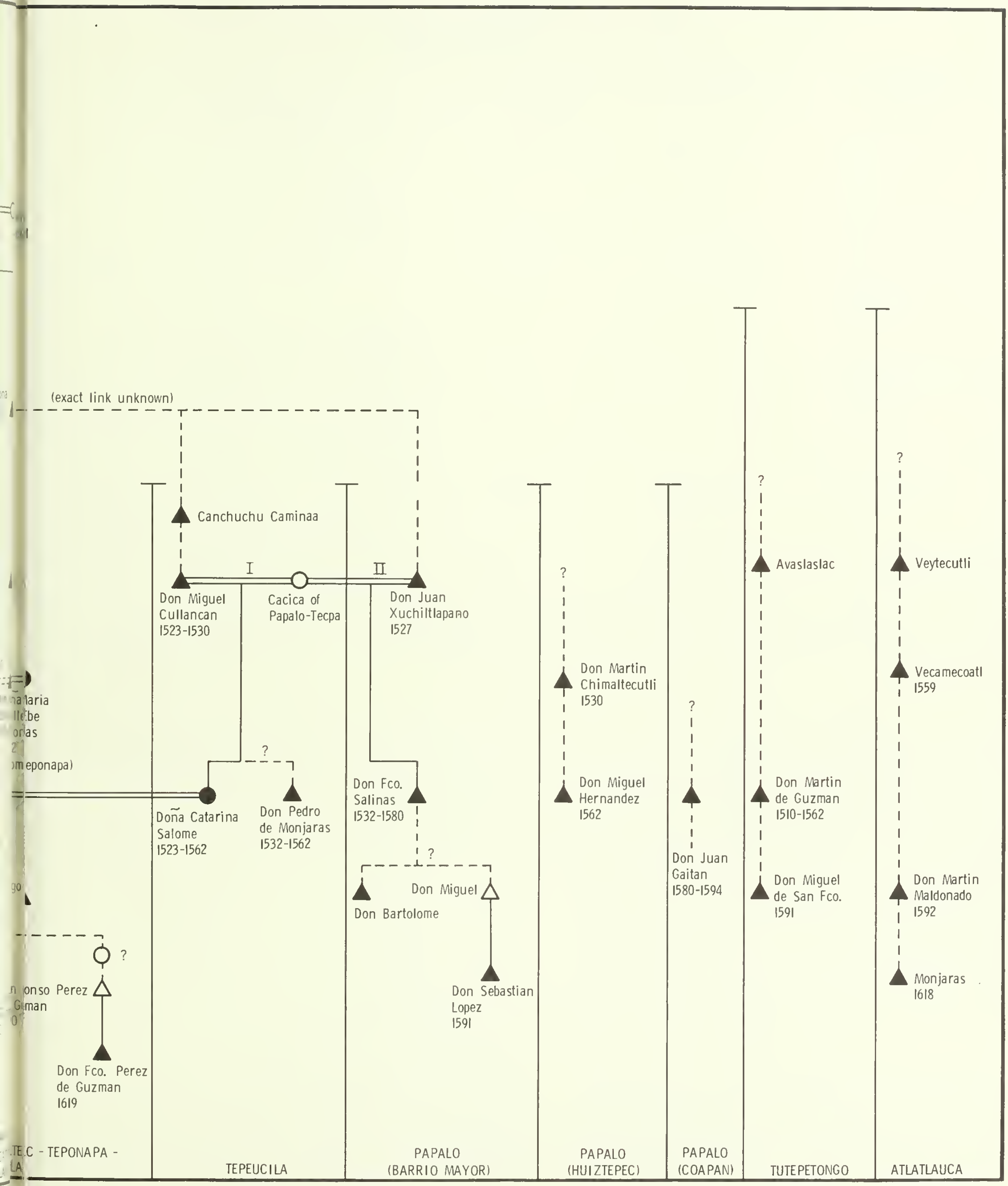

KEY
Male
Male known to have ruled the settlement in the column listed
Female
Female known to have ruled the settlement in the column listed
Note: dates indicate periods for which information is available
Mythical epical ancestor (Teutli) 1172
Cacica of Quiotepec and Salado-Tecomavaca
I
II
Citlaltecuhtli 1432-1458
Notasinguey (Our noble father ?) 1459-1484
Xnaghanihiña
Cuhuantecuhtli or Coatecotle or Naiye-Tico 1485-1511
Cihuapili Omemiquiztli
Don Fco. Cortez Tecohtoztli 1511-1523
(Senior line?)
(Junior line?)
Tiñaña or Tcuantecotle 1510
Chicomecoatl 1523
I ?
II ?
Doña Marta de Espinosa 1527
Don Fco. de Monjaras 1555-1590
Doña Juana de Salazar 1523-1591 (Cacica of Tonaltepec ?)
Don Pedro Cuetlaxtecutli 1550
Don Alonso de Mendoza 1555-1562
?
Don Miguel de Monjaras
Don Gabriel de Monjaras 1591
?
Don Juan de Monjaras 1619
Don Pedro de Monjaras 1618
Don Benjamin Ladron de Guevara 1883-
Doña Maria Cuetlaxtecutli 1537-1562
Don Domingo Hernandez 1537-1562 (Junior line)
Doña Maria Hernandez 1582
ditonidona Yztecutli 1510
(Commoner ?)
Don Mart Toxtecutli 1524-1542
Don Juan de Guzman 1592
CUICATLAN
TECOMAVACA - QUIOTEPEC (HUIZTAPA)
QUIOTEPEC, PAPALO - CACALOTEPEC, and PAPALO - TECOMALTIANGUISCO
PAPALO (ZAPOTIT LLANO TI

Fig. 99. Gene


(exact link unknown)
Canchuchu Caminaa
I
II
Don Miguel Cullancan 1523-1530
Cacica of Papalo-Tecpa
Don Juan Xuchiltlapano 1527
?
Doña Catarina Salome 1523-1562
Don Pedro de Monjaras 1532-1562
Don Fco. Salinas 1532-1580
?
Don Bartolome
Don Miguel
Don Sebastian Lopez 1591
?
Don Martin Chimaltecutli 1530
Don Miguel Hernandez 1562
?
Don Juan Gaitan 1580-1594
?
Avaslaslac
Don Martin de Guzman 1510-1562
Don Miguel de San Fco. 1591
?
Veytecutli
Vecamecoatl 1559
Don Martin Maldonado 1592
Monjaras 1618
?
Don Fco. Perez de Guzman 1619
TEPEUCILA
PAPALO (BARRIO MAYOR)
PAPALO (HUIZTEPEC)
PAPALO (COAPAN)
TUTEPETONGO
ATLATLAUCA

catec dynasties.

TABLE 15
The Class Structure of the Cuicatecs

	Description	Cuicatec title or name	Nahuatl title or name	Spanish title or name
Elite	Traditional patrimonial ruler; overlord of the state.	Ditonidona (*sic*)	tlatoani (?)	Cacique Mayor
	*Private counsellor to the overlord.	....	....	Ayo
	*Administrative staff of elders.	....	....	Ancianos
	*Minor lords, magistrates, with prebandal rights over subject estancias and barrios.	Dyille Ebe (f) ii'ya (m)	Tecuhtli (m) cihuapilli (f)	Cacique or Cacica Menor
	Army officers.	....	....	Capitanes
	Priests.	....	....	Sacerdotes
	Other "unemployed" members of the aristocracy (?) (e.g., children of concubines, etc., who could not succeed to office).	....	....	Ramas de la nobleza; Principales
	Female curers or medics and traders (social status ambiguous).			
Commoners	Administrative assistants of local communities.	nyandi	tequitlatos	(as Nahuatl)
	Free commoners. The bulk of the peasantry; servants; army recruits in time of war.	....	macehuales	naturales (terrasgueros)
	Slaves and/or prisoners of war; sacrificial victims for the temples.	....	....	esclavos

*These were partially replaced by the Spanish government, in the sixteenth century, with the posts of Gobernador, Alcalde, Mandón, and Regidor.

sided permanently in the hamlet of which he was in charge, and the rest of the macehuales. Macehuales were permanent residents of the settlements where they were assigned plots to cultivate in order to support their families. Macehuales had certain specializations. We do not know how much time was allocated to specialized activities, but we know that sometimes the specialization was attached to a person's surname: for example, there were men named "the fishermen." This is probably true also of curers or doctors. Today in the Cuicatec region male curers are nicknamed "Lightning" and females are called "Malinche" or by words meaning witch or sorcerer. Among the existing specializations were salt workers, weavers, builders, painters, musicians, and house servants. We do not know how many of these were culturally recognized "professions" nor do we know whether they were ranked internally. However, we do know that these specialists were not land-bound and could migrate to other communities. In Atlatlauca, "slaves," whose status is not clear from the information given, have to be added to the list.

To say that two major classes or estates existed among the Cuicatec is not far from the truth. They were distinctly different in kin networks, wealth, political power, and prestige. Each was probably endogamous and, though the elite men had commoner concubines, legitimate spouses had to be of noble rank. There was clear distinction in the division of labor and different usufruct rights over the means of production and surplus, and each was integrated into a social system that was clearly rank stratified on the basis of both ascription and achievement. From the present evidence the social pyramid must have looked something like the accompanying Table 15. Relative rankings in some cases, however, are an educated guess.

Caciques' Genealogies and Succession Rules

Information on succession rules for the Cuicatec dynasties comes from two sources. Direct statements are found in the Relación de Atlatlauca (*PNE,* IV: 163-176). Several stated rules of succession and factual data on succession cases appear in the 1562 document.

In Atlatlauca, the overlord's title passed on to the first son of the senior wife (*PNE*, IV: 167). That is, the primary rule of succession was patrilineal primogeniture. The children of junior wives and concubines could not inherit the father's position. They were members of the cacique's household but their status was "illegitimate" (*loc. cit.*). If there was no legitimate direct issue, a collateral of the cacique, rather than a child of a junior wife, became the cacicazgo's heir (*loc. cit.*). This regulation, complementary to that of patrilineal primogeniture, maintained the executive posts within a legitimate line of a particular descent group. As among the Inca (Gibson 1948), two parallel traditions of legitimate succession seem to have coexisted. One emphasized agnatic succession of males, primogeniture, and patrilineal descent. The other, which appears closer to the realities of succession ca. 1500-1550, points to ambilateral succession to legitimate senior children of either sex. It is possible that one tradition reflected jural rules and the other the realities of actual historical succession. It is also possible that they reflected differences between a patrilineal Mexica type of succession and a local Mixtec-Cuicatec norm of ambilateral succession. All this requires a careful critical evaluation with the realization that the documents from which the information is obtained were often designed to influence the Spanish courts (e.g., Relación de Pomar). But even though this source (*PNE*, IV: 167; IPCCS passim) indicates that patrilineal succession was a primary regulation, it also states that the mother of a cacicazgo's heir had herself to be of noble or aristocratic lineage. Our suspicion of patrilinearity for succession is also reinforced by the evidence of bride-price (*loc. cit.*). Since both mother and father had to be of royal houses before succession was possible, it seems that a secondary line of descent, or filiation, on the female lines was also counted. Thus, it is more likely that the Cuicatec elite reckoned descent either ambilaterally, or on the basis of a corporate kindred descent system. We favor the first interpretation, because ambilaterality offers more internal stability in maintaining a rank-distinct descent group, and also because other Mesoamerican groups are known to be ambilateral, or there is strong evidence to support such interpretation.

The Papalo genealogies support the Atlatlauca evidence, with one exception: multiple succession was possible for all legitimate children of a ruler. The total set of succession rules that can reliably be elicited from the Papalo manuscript is presented below:

1. Acquisition of the lord's position was possible only to legitimate descendants of the direct line of cacique's families, reckoned in both maternal and paternal lines.

2. Only children born of legitimate wedlock between members of the cacique's and aristocratic households were able to succeed to the major lordship. Children of sequential senior marriages, if the first senior wife died, could all inherit a state's subject territories, but not children of contemporary polygynous marriages, secondary wives or concubines, who were considered aristocratic but not "royalty."

3. All legitimate children were candidates for succession. It was one of the rights of a cacique, and possibly of members of the elder's council, to select among his children those who were to succeed to different territories, specified by him from his own holdings.

4. Females could succeed as well as males, following male lines, and vice versa.

5. Caciques could inherit rights of succession to different territories, separately, from the mother's or the father's states. These became "united" under one ruler, but each maintained its identity as a separate political community and was held independently of the others.

There also appears in the Papalo manuscript a case which suggests that, due to circumstances wherein a cacique's successor (Don Diego Ximenez) was too young to take command, a sort of regency was established, in which an adult kinsman, a half-brother of the father, administered the cacicazgo until the heir was of age. The information, however, is complicated, as the legal suit between the young cacique's mother and her father's brother, who was "regent," involved the expulsion of Don Diego's mother from the estancia by the husband's brother, and the complicity of the mother's half-sibling who was Indian Governor at the time. Thus, what can be read as a legitimate regency can also be read as an attempt to usurp rights to a legitimate succession by a collateral line.

The following factual evidence supports these ideal rules. *First*, legitimacy claims are always defended on the grounds of direct succession from legitimate offspring, and the identification of both mother and father, plus their cacicazgo titles (IPCCS: 1, 23, 49-50, 75, 76, 85). *Second*, the only son, Don Domingo, of a junior wife whom we have in the genealogy (Fig. 99) did not succeed to his father's position. Only those had done so whose mothers were themselves daughters of caciques and principales, and had married a cacique and occupied the position of senior wife (*loc. cit.*). *Third*, when two children of a cacique, who each inherited part of his political domains, were from different marriages, each union had taken place serially, and not simultaneously. Both Citlaltecutli and the mother of Doña Catarina Salome had married serially after the first spouse's death (see Fig. 99). Don Martin Toxtecuhtli, however, had had Don Lorenzo by his senior wife and Don Domingo by a secondary wife whose claims to nobility were apparently so obscure that not even one witness mentions her position or status. Half-siblings, of the first two cases, succeeded to parts of their parents' states. But Don Domingo had not (*loc. cit.*). Because of multiple succession on the first two cases, Papalo had been divided into separate lines. One cacique controlled the settlements of Yepaltepec, Zapotitlan, Coyula, Teponapa, and Llano Tiopa (see Fig. 82). Another controlled Cacalotepec and Tecomaltianguisco. Two other caciques whose connections to the first two lines are not completely known, controlled the Barrio Mayor Tecpa and the barrio of Huiztepec (19). Because of succession on both female and male sides, Don Lorenzo Toxtecutli, who inherited Yepaltepec and the other associated estancias and barrios from his father, also received from his mother, the Dyille Ebe of Teponapa, an extra estancia. Again, the cacica of Cacalotepec and Tecomaltianguisco had received these estancias from the succession lines of Citlaltecutli, and the cacicazgo of Quiotepec and Salado-Tecomavaca from Citlaltecutli's first legitimate wife (20). *Fourth*, in each one of these cases, the parents had divided the cacicazgo's rights among their children. *Fifth*, the cacicazgo of Tepeucila had been inherited by a female, from her father, and after her death it was expected that her son would succeed her (for clarification see Fig. 99).

Multiple succession seems to have promoted fission of the state into separate territorial political subunits under different ruling heads, and a certain amount of antagonism between collateral kinsmen. The Yepaltepec-Cacalotepec division from Citlaltecutli's two sons, was still being fought by their descendants four generations later because an original prebendal grant had become a stable succession line (IPCCS: 47). Two half-sibling lines, a double marriage link in the generation before 1562, and one other affinal link formed ca. 1540, complicated the picture of succession rights, and made the political separation between the two estancias doubtful. The Spanish courts, however, granted the cacicazgo's succession to the line of Yztecutli, a line which was purely Cuicatec (the Cacalotepec-Tecomaltianguisco line was also ruling over Mazatec communities). Such ambiguities in the regulations must have created havoc among honest civil servants who wished to base decisions on which line to follow on established native principles. (Cf. Gibson 1964 for the equivalent situation in the Valley of Mexico, and Spores 1964 for a Mixtec case.) Curiously, Cacalotepec is now part of a new municipio formed on the border between Papalo and Tepeucila, and one may question if this history of fission does not connect with the earlier territorial political fission of the Papalo state.

Marriage between caciques increased the political holdings of a particular successor in the following generation, because he could inherit from both parents. Ambilateral inheritance and succession rules thus could have promoted fusion of states into a larger political system. But multiple succession in following generations worked in the opposite direction, for it favored fission of territorial nuclei by separate ruling families. Clearly, however, the Cuicatec elite attempted to unify the states by intermarriage of ruling households of collateral kinsmen. That is, Cuicatec cacique marriages were made with political purposes in mind. All the marriages of which we have information were town exogamous but ruling class endogamous; two took place between close collateral kinsmen who were probably first or second cousins. Furthermore, they were arranged for specific political reasons. Citlaltecutli had married the cacica of Quiotepec about 1458, to solve the old enmity between the states of Papalo and Quiotepec-Tecomavaca over the Yepaltepec-Papalo lands, because of the war fought ca. 1172 (IPCCS: 67). About the time of the Conquest, Don Martin Toxtecutli, lord of several Papalo settlements, and Cullancan, cacique of Tepeucila, who were close kinsmen (the exact link is unknown), had married their children and heirs to solve between them a dispute over the territorial rights of each (*op. cit.*, 9) (21). The closeness of kinship is obvious from the fact that they had to petition the church in order to legitimize the marriage by special dispensation. Endogamous marriages within the noble class for the purpose of pacification or settlement of territorial disputes could have served the same final purpose, that is, the strengthening of the ruling house and the centralization of political rights. But since fission was also operating in each generation, fostering factionalism between collateral lines, a precarious balance of allegiances and enmities maintained the Cuicatec state dynasty lines in a state of flux, without achieving greater political centralization.

One important aspect of noble marriages is class endogamy. The other important aspect of intermarriages is their cross-ethnic group character. Of the seven marriages of which we have information, three were between rulers of different Cuicatec settlements, and four were with rulers of different language groups. Citlaltecutli had married into Quiotepec and Teutila. One cacica of Quiotepec had married into Papalo, and from a different source we know that a daughter of the caciques of Quiotepec had married the cacique of Cuicatlan (Peñafiel 1895; Adan 1922). This indicates that the dynastic lineages of some of the states of Oaxaca crossed language boundaries, and probably ethnic identification in community origin was not a determinant of royal allegiances, but rather territorial propinquity and common class interests. The same situation appears in marriage connections of Mixtec and Zapotec elites (e.g., Relación de Cuilapa).

Several later caciques of the Cuicatec appear in the Archivo General de la Nación as receiving grants of tribute demanding land restitution or as being granted salaries or special rights. At present, their connection with the previous dynasties is not known, because names and surnames were, during this period, in the process of changing from native to the Spanish nominal system. (Cf. Hunt, Hunt, and Weitlaner 1968 for data on native Cuicatec naming of the nineteenth and twentieth centuries.) Since the focus of this work is on the period prior to or immediately after the Conquest, they will not be discussed extensively here. Suffice it to say that at least until 1619 caciques were being recognized and assigned special status, either as caciques or by placing them in the officership of governor in the locales in which their fathers had ruled: this was only granted after Spanish investigation had clarified the record that they were legitimate heirs according to local succession laws (AGN, Ramo de Indios: Vol. 1, Exp. 30, 162; Vol. 2, Exp. 74, 301, 881; Vol. 3, Exp. 431, 517, 767, 908, 950; Vol. 5, Exp. 917; Vol. 6 (Second Part), Exp. 660; Ramo Mercedes, Vol. 5, Exp. 357).

From the evidence presented, it becomes clear that the system of royal succession utilized by the Cuicatec was in its main lines similar to, and as complex as, that of the Mixtec ruling houses. We have more detailed information on the Mixtecs, because of Caso's and Dalhgren's work (Caso 1960*b*: 20-22; Dalgren de Jordán 1954; cf. also Spores 1964). No major contradiction between Mixtec and Cuicatec succession rules appears, while both appear to be different from the Mexica system. This reinforces the previous interpretation that (a) there is a general similarity between the Cuicatec states and those of the Mixteca Alta, and (b) a connection between Mixtec, Cuicatec, and Mazatec ruling houses or dynasties existed in pre-Hispanic times.

The major difference, internally, between our two sources on Cuicatec succession seems to be the regulation of primogeniture indicated for Atlatlauca. Two explanations are possible. It could have been the case that to inherit a state capital, as against an estancia, primogeniture was required. Since the Papalo manuscript deals with an estancia and not with the cabecera, the topic did not come up, and the rule was not stated. It could be possible, in this case, that the Atlatlauca primary rule was complemented by additional regulations about the disposition of subject settlements, rules for which at present we have neither direct evidence nor materials from which they could be elicited. The other possibility is that Atlatlauca and Papalo had slightly different succession laws. The first, however, seems to us a better hypothesis. Further work on materials in the Archivo General in Mexico and Spanish archives may solve the problem by completing this tentative picture. Again, future analysis of codices of Cuicatec origin, which may contain genealogies, may also serve to sharpen the present incomplete analysis (Cline 1966).

Proof of descent in direct lines was kept in these codices, which were carefully guarded by the Indian officers (IPCCS: 49, 74). Written tribute grants, tasaciones, acquired some of the same value, since both were utilized in the Spanish courts to determine the legitimacy of succession claims. In the absence of codices, the first tasaciones made by the Spanish during the first Viceroyalty were considered equivalents, or sufficiently documented substitutes. In this context, it is important to note that Doña Catarina and son, of Yepaltepec, claimed that Don Domingo had stolen all the codices and tasación titles which proved her rightful possession, by taking them from her by force. The Spanish tasaciones had apparently, in their view, taken the place of the old native codices in legitimizing political rights.

Decisions on succession were not legitimized unless (a) a cacique lived in the state he was supposed to rule, (b) the community macehual population accepted his rights "without contradiction and peacefully," (c) rulers of other connected subject settlements of other estancias or barrios and of territorially adjacent states accepted the heir as having legitimate claim over a particular political unit, and (d) the heir presumptive was not a minor. Before a cacique could be accepted, the rulers of adjacent towns and the macehuales of the locality were brought as witnesses to court, and were then required to walk the whole length of the boundaries of the cacique's domain. They also performed an elaborate ritual which involved carrying the cacique on their shoulders, adorning him with flowers, and throwing stones in the four directions of the compass. In the end they indicate their willingness to recognize him as their cacique and to support his claims of succession.

By 1562 the original female ruler of Tepeucila, Doña Catarina Salome, had to surrender her rights to a kinsman (the connection is not known exactly), because she moved, at the time of her marriage, to reside in Papalo (IPCCS: 76 passim). In 1582 one of the Papalo caciques who moved to Teutila and did not perform his duties as expected, "did not continue enjoying the personal services and other help which used to be given" (AGN, Ramo de Indios: Vol. 2, Exp. 74) (see Note 14). The tasación given to Don Martin Toxtecutli and Don Lorenzo Toxtecutli and their acceptance and possession ceremonies were dependent on their acceptance by the rulers of Cacalotepec and Tecomaltianguisco, among others. Again, in 1562, the acceptance of Diego Ximenez was explicitly required of all macehual inhabitants and caciques of neighboring estancias, who did not contradict his rights. (For records of other caciques agreeing to *posesión* ceremonies, see IPCCS: 2, 27, 31, 33.) Probably one of the major factors in the failure of Domingo Hernandez to win from Don Diego the Yepaltepec cacicazgo rights was the fact that Don Diego had as his allies the macehuales of his own estancia, the governor of the Papalo headtown, and the reigning cacique of Cuicatlan, while Don Domingo presented witnesses who were either Mazatecs from Cacalotepec or Cuicatec Indians from communities which were not located at the borders of Yepaltepec (e.g., Alpizagua and Tutepetongo), and thus had no legitimate support to offer. Macehuales and their communities supported native rulers who could provide them with access to water sources. Thus, the Mazatec Indians and principales of Quiotepec were giving Don Domingo support in his *pleito*, because "he had promised to solve it (their petition to the local Spanish judge to obtain the water of Yepaltepec free) in their favor, because they have a noticeable scarcity of it (water) to irrigate their parcels . . . (and) since the old war do not use it (the water) for more than the daily needs (*gasto*) . . . and to irrigate Doña Catarina (Don Diego's mother) makes them first ask and pay for it" (IPCCS: 31-33). As the reader may remember, the Indians of Yepaltepec, however, supported Doña Catarina and Don Diego, because "the water was theirs, and came from their hills" (*loc. cit.*).

Sources of Power of the Elite

The original power of the local Cuicatec elite was supported and maintained by the imperial Aztec and Spanish administrations. The Aztecs fostered this development by their policy of indirect ruling. The Spaniards followed their example, at least until the time when they had a sufficient number of skilled civil servants of their own residing in the area. By the end of the seventeenth century the Indian lords of the Cuicatec had lost their importance as political figures and the basis of their power was destroyed. But in the earlier periods of the Colony, and well into the beginning of the seventeenth century, Indian rulers of the Cuicatec province were still selected on the basis of the native principles of social organization. In the sections below we will survey the old structure and its changes up to the end of the sixteenth century.

After Spanish domination, caciques of estancias, such as Lorenzo Toxtecutli and others, had considerable responsibilities. They could not wage war against neighbors because the Spaniards forbade warfare; nor could they fill the ranks of the priesthood, since Indians could not be trained for that role (Ricard 1933: 411-412, Notes 62-67; Galvan Rivera 1870; Robertson 1959). The Colonial priests of the Cuicatec of whom we have information were not Indian, but sons of conquistadores. We know of two, Martin de la Mezquita and Esteban de Alavez. Esteban de Alavez was beneficiado in charge of the partido of Teutila, to which Papalo was incorporated, and was the son of the conquistador Melchor de Alavez who helped take Tenochtitlan and Oaxaca (R. de O.: 96; Icaza 1925: 54, 196). He was also the brother of a famous priest of Oaxaca (Burgoa 1674: 437, 484, 486-490, 492, 494, 495). Martin de la Mezquita was probably a son of the conquistador of the same name who entered Tenochtitlan with the troops of Narvaez in 1519. He may also have been a kinsman (brother?) of the corregidor Francisco de la Mezquita who wrote the Cuicatec Relación de Atlatlauca (R. de O.: 96; Icaza 1925: 198; *PNE*, IV: 163).

Although Cuicatec caciques could not wage war nor run their churches, they did have considerable responsibilities. As representatives of their communities, and with popular support, they had the power to carry territorial conflicts into the Spanish courts. The means and the locale had changed but the purpose and function remained; moreover, their administrative tasks were not contended. In 1562, and at least until 1590, they had control of land redistribution, and still received maintenance services in exchange (cf. Notes 11, 13). (AGN, Ramo de Indios: Vol. 1, Exp. 162; Vol. 2, Exp. 757; Vol. 3, Exp. 80, 81). They were the caretakers in an economic network which involved large tribute grants. They administered the allocation, evaluation, and payment of local tribute to the imperial bureaucracy, first Aztecs and later Spaniards. They still had the right to receive personal tribute which was ratified in cacique tasaciones, sometimes attached to the tasaciones of towns (AGN, Ramo de Indios: Vol. 1, Exp. 162, 279; Vol. 2, Exp. 881; Vol. 3, Exp. 767, etc.). They still had the right to extract water tribute from neighboring users, when the communities they governed controlled the source of the river. They served as gobernadores, alcaldes, translators, mandones, etc. in these newly created posts of the Spanish system of government. And, most importantly, they were still fully recognized by both Indians and Spaniards as an autochthonous nobility with privileges, such as special clothes and food, derived from their rank and with superordinate political rights over the majority of the population and a traditional legitimate right to represent them. These rights were what Spanish scribes referred to as "*propiedad*" (ownership rights of caciques), and interpretations of the records to the effect that they refer to personal private ownership are erroneous.

Propiedad did not involve "ownership" in our meaning of the word, but rather rights to certain specified actions on their part toward others and vice versa. At the estancia level, for example, *propiedad de las tierras aguas* by no means meant private ownership of land and waters. The community itself was the corporate depository of such rights. Lands and water were entailed, and could not be sold or disposed of by the cacique according to his will. What it meant was that the cacique was duty-bound to administer this property for the local peasantry in exchange for some extraordinary privileges, such as land redistribution, organization of tequios in exchange for trade goods or laborers, and usufruct of parcelled office land.

Land redistribution, in this context, may have served to protect the traditional political rights of the cacique in aboriginal times. Redistribution of land to the peasantry, carried out on a yearly basis, could have served to prevent the monopolization of better parcels or more productive locations on the part of families of the commoners class, and might have maintained the whole group at an homogeneous level of wealth. That is, it could have prevented the growth among commoners of wealthier family groups who may have desired, once they had the economic means, to challenge the rights of the cacique to control the local scene. Thus, we believe, land redistribution must have restricted the growth of political opposition to the cacique houses. By this method both the cacique and the community as a corporation were insured of their continuous control, as long as no new forms of land control developed from causes other than the internal demands of the system. Inasmuch as the caciques were the only political figures which had administrative control of land and water for communally-held property, they were able to maintain their political monopoly. If no one within the estancia could monopolize the usufruct of better lands, the community insured itself against class factionalism and land fission. The surrendering of some rights to persons of a "foreign" minority class, a single descent group not locally bound in its interests, maintained community unity. It also, however, allowed for the growth of other monopolistic powers in the hands of a minority elite.

The rights of a cacique to rule over an estancia, and to receive tribute, were not legitimized exclusively by proof of direct aristocratic descent because position in line of descent was, of itself, not sufficient for succession. The cacique, once legitimacy was established, received tribute "because he reallocated the parcels to the macehuales, every year in different places, without receiving other payment" (IPCCS: 19, 61, 63, 67, 71 passim). In other words, his political privileges were directly related to his duties as administrator of communal lands and waters. Caciques administered such parcels exclusively for the communities which they ruled and within cacicazgos in which they were residents, since pre-Hispanic times. Statements on this in the Papalo manuscript occur in multiple locations, all with practically identical phrasing. Clearly, the legitimacy of the native ruler and his importance as a political figure were directly related to his administrative duties with respect to agricultural production, not only in the eyes of the interpreters, but in the eyes of the contemporary Indian witnesses themselves, who were quite explicit and insistent about it.

In addition, there is no doubt that in pre-Hispanic times the nobility derived political might from their control of the army and the monopoly of temple services. The relaciones are quite explicit on this point, indicating that the cacique was a war leader and appointer of military officers, and that temple priests who had large powers vested in them, were also selected by caciques and from aristocratic kinship lines. The Papalo manuscript also emphasized as a source of power, the role of warfare in territorial control over both land and scarce water sources. In this case, the cacique was the leader of any military endeavors in which the community engaged.

At the estancia level, the theocratic functions of the local elites do not, at first observation, seem to have had the same importance as in the pre-Hispanic past. No witness in the 1562 manuscript refers to these religious aspects of the cacique's rule. It is obvious to us, however, that the absence of this topic is due to the repressive actions of the Spanish authorities over anything suspicious of "idolatry." The astute writer of the Atlatlauca relación makes this point very neatly (*PNE*, IV: 167). The large number of rituals today of pre-Hispanic origin — especially those connected with hilltops and water deities, equivalent in content and symbols to Tlaloc and Chalchihuitlicue — and the present use of pre-Hispanic objects, such as knives and curer's tools, for ritual and divination, attest to the importance of religious activities in the sixteenth century and before; as do the ruins of ceremonial complexes attached to the towns and the divinatory-ritual-calendrical contents of the Codex Porfirio Diaz Reverso (Nicholson 1966; Weitlaner 1961; Weitlaner and Holland 1960).

Whatever their other sources of power, it seems hard to refute that part of the ability of the ruling class to monopolize political power was related directly to a cacique's duties as administrator in relation to the agriculture of irrigation and the redistribution of land, and that it was partly from these that the society legitimized his power. In other words, there was a direct relation between political power and the economy of irrigated agriculture. Among the provincial Cuicatec, agriculture did not "take care of itself," and the native rulers or lords were very much involved in its administration, although they were not cultivators themselves. Unlike situations involving large hydraulic systems, the elite apparently did not depend on control of monumental waterworks, extensive land holdings, and the like, but rather on their ability to provide military leadership to control scarce water sources, religious leadership with respect to water deities, and the calendar (?), and administrative skills to redistribute irrigated land, and tax water use. Added to this was the need to schedule and organize communal labor, or tequios, which involved the necessary team work to build public works and service the water canals. This "provincial" situation seems to contrast with Adams's conclusion in regard to the Aztec that the elite was not actively engaged in providing leadership for agricultural management (1966: 167). The difference in interpretation for the Mexica and for the Cuicatec is probably a *real difference in their social organization at the time of the Conquest.* That is, both statements are true. The explanation seems very simple if we compare the two situations with modern "Colonial" situations in Latin America, relative to Prebish's theory of economic centers and peripheries (1963). The Mexica stood to some of their subject "nations" or colonies, that is, to those colonies with whom they traded or whose economy they indirectly controlled through tribute, as a center of production of valued manufactured goods vis-à-vis a periphery of producers of food, other agricultural products, and raw materials. Although the economic base of the "Empire" was agricultural, the focus of activity of the capital center itself was crafts and trade. Calnek (1960, 1969*b*) has shown, I think conclusively, that Tenochtitlan itself was composed primarily of *calpulli* of people engaged in professions other than farming. Calnek (pers. commun.) suggests a distinction between internal and external provinces in the Aztec system. There is a lack of adequate research on the levels of integration of the Aztec alliances, but it is apparent that in the vast majority of the "nations" (that is, chiefdoms, village- or town-states, ethnic or other units) of the economic-political periphery, agriculture was, not only the base of the society, but also its production focus. Thus, the relation of the local political elite to the economic realm of the society's life had a different base. While the Aztec ruling groups were concerned with warfare, religion, manufacturing, trade, and the control of the periphery as an economic hinterland, the rulers of colonies were more directly involved in the problems of agricultural management. We find today a similar situation repeated in Latin America, as compared with the U.S.A., in which the ruling classes of the underdeveloped countries are much more directly involved in the affairs of agriculture. They are the major landlords, owners of haciendas, latifundios, and exporters of raw materials, not the manufacturers or industrialists. Historically then, the provincial Cuicatec stood in relation to the Mexica as the antiquated rural elites of Latin America stand to twentieth-century Washington and New York.

After the Aztec conquest, an added source of power was the support of foreign conquerors, who gave the caciques the right to continue to collect tribute for themselves and to collect local tribute for delivery to the agents (*calpixques*) and garrisons. Related to this, it seems probable that the caciques derived part of their influence from their pre-Hispanic control of trade and the exchange of special goods. In Tepeucila, the local salt mine and its production was under cacique control from ancient times (*PNE*, IV: 98). Since salt was obtained through damming and evaporation, one could suspect that the cacique was also in charge of the direction of labor. The same situation was prevalent in the salt mining towns of the valley of Tehuacan, including the cacicazgos of Teotitlan del Camino and its subjects (AGN, Ramo de Indios: Vol. 7, Exp. 89, 129; MacNeish, Nelken-Terner, and Johnson 1967: 23-24, 46, 135). Mendizabal, in his original study on the salt mines of Mexico (1929), indicates that "private," or, as we would prefer, "restricted" exploitation of salt sources by caciques accompanied the techniques of damming and solar evaporation which require communal labor. Public or free exploitation was a relatively new development that came about when the firing techniques of salt evaporation were introduced from northern Mesoamerica by migratory groups (*op. cit.*, 187-188, 194-195).

The lack of further integration and consolidation of the political power of the Cuicatec elite, i.e., macrostate centralization, seems to have been related in pre-Hispanic times to the schismogenetic tendencies of the territorial units which controlled different water sources, and the fission of dynastic lines (cf. Bateson 1958 for a definition of schismogenesis). As we have discussed above, tendencies toward fusion always seem to have been counterbalanced by rivalries over water control and by fission along sibling cleavages in the ruling houses and their subjects. Part of the process of fission may have been induced by local population migrations, which produced temporary political instability. In addition, there may have been a desire to expand the territorial domination over frontier lands where irrigation was possible. But control was difficult to maintain because of technical-administrative difficulties in holding together the state, due to mountainous topography and poor communication. The territory could not be unified for any considerable length of time, controls broke down, and fission may have taken place, producing the opposite effect; that is, territorial restriction rather than expansion. A similar process has been reported by Leach (1954) for the highlands of Burma; that is, centralization was not favored by the balance of territorial size, population size, and level of technology. Partly, fission may have also been produced by the ambiguity of succession laws, and the proliferation of prebendal distributions. Whichever is the correct answer, if in fact any one can be said to hold the key to the problem, is purely hypothetical. But the two types of factors, one ecological-cultural and another produced by socio-structural pressures, seem clearly to emerge as sufficient causes. This topic is discussed in a larger perspective in our concluding remarks.

We know, however, that once territorial separation was accomplished and a new community and water source assigned its own ruler, political independence was attempted. In Yepaltepec the process took, at a maximum, four generations, and the road was inscribed with conflict between kin, legal haggling, theft of documents, exile of caciques, threats on personal life and property, intimidation and bribing, and so on. We have two detailed accounts of fission movements, which are separate in time and place, that indicate that the same processes of territorial fission are at work up to the present time. (Other cases of conflict without final fission are much more abundant.) One took place between 1893 and 1909, when San Miguel Santa Flor separated from Chapulapa and Cuyamecalco, one an underpopulated Cuicatec community, the other an overpopulated Mixtec community. The migrants moved in search of watered land to cultivate, which Chapulapa was willing to rent and Cuyamecalco lacked. The other took place between 1950 and 1965 when the communities of Rio Hondo and Chorro de Agua, two subjects of San Andrés Teotilalpan, all Cuicatec settlements, obtained separate political status. The initial movement originated in political disagreement over the administration and usufruct rights of a landed private property located in an alluvial flat of the local river. In both cases political fission followed territorial and kinship lines. In both, two antagonistic kinsmen, who were the local political figures of importance, caciques in the modern sense of the word, promoted the migration of part of an original settlement to form a separate hamlet. In both cases each was supported by a nucleus of ambilaterally related kin. In both cases attempts at political separation were followed by small, warlike skirmishes between opposed parties (called *tumultos*), court cases, physical attacks on influential persons, and revenge murders. Tumultos appear to be modern versions of local wars over water or land. All cases known to us follow the same pattern as the pre-Hispanic one. When two communities had a conflict over a water source, both moved their men to "plant" corn around it and surround the spring with their own milpas as proof of earlier occupation or "colonization." Their meeting of men "going to plant" is curious, since all carried guns and rifles, in addition to the machetes which could be justified on other grounds, and immediately engaged in armed conflict, right at the water source. Court cases follow tumultos, when neither party clearly succeeded over its competitor in establishing its claims, on the basis of a "military" victory. The court cases appear named as between individuals, but the texts indicate that they involved groups of men in each community, the title men being the leaders of the tumultos (e.g., Averiguación Instruida contra los vecinos de Apoala . . . Archivo de Cuicatlan, 1878; Contra los de Atlauca, por heridas, Archivo del Juzgado de Cuicatlan, April 1878; En contra de A [of Tutepetongo] por el delito de lesiones, A. J. Cuicatlan, 1940; Rodriguez vs. Rodriguez, Paraje Zempoala Vuelta of Cuyamecalco, A. J. Cuicatlan, 1924; Soyaltepec; AGN, Ramo de Tierras, Vol. 742, Exp. 4; Vol. 789, Exp. 4; Vol. 868, Exp. 8; Vol. 1351, Exp. 37). Finally, in both cases, within one generation of territorial separation, political autonomy was legally granted. The evidence for this modern section had been collected from the archives of local courts both in Cuicatlan and San Andrés Teotilalpan. Since the archives are not arranged by case, but by year, references are thus identified in the list of unpublished references at the end of the chapter. Most of the manuscripts are not even kept up as records, but are in bundles in the back room of the Juzgado. Since they are named, however, the name of the "case" is added to the date to facilitate any future research. (Archivo del Juzgado de Cuicatlan, documents pertaining to the separation of San Miguel Santa Flor: Years 1893, 1897, 1902, 1909; Archivo de San Andrés Teotilalpan, municipio, documents pertaining to the separation of Chorro de Agua: Years 1950 to 1965 inclusive; cf. also references above.) In both cases fission reestablished the population balance in terms of density of population-available agriculture land ratios.

In pre-Hispanic times the leading classes may have seen the benefits for themselves in political consolidation of separate territorial political units. Constant petty fighting, although it may have given them some possibility of strengthening their power on the basis of military leadership, also drained the wealth of the communities, resulting in a decrease of the cacique's economic privileges. Political integration, on the basis of intermarriage between locally powerful ambilateral cacique lines, could have consolidated their power over larger territorial units, and insured peaceful economic growth on the one hand, and the extension of their privileges (based on the control of surpluses from a much larger and wealthier area with ecologically complementary production utilizing both highland and lowland crops).

This steady enlargement and consolidation of political units was interrupted externally as well as internally. After the Aztec conquest factors external to Cuicatec society entered the picture. First, the Aztecs forbade warfare (*PNE*, IV: 90, 186). Thus, local territorial political units became fixed. Second, they officially designated the caciques as their own local administrators to collect tribute on the basis of the established sociopolitical units. Thus, they promoted the maintenance of a very precarious status quo of small, antagonistic, and easily controllable territorial groups and their leaders. It is obvious that the Aztecs and the early Spanish colonialists found it convenient to use the already existing political authorities to carry on their own business in exchange for maintaining their older privileges. The Cuicatec rulers may have also expanded some of their privileges after the Aztec conquest, by having new rights vested in them by the conquerors to insure their loyalty. In this sense, the Cuicatec aristocracy became also a bureaucratic branch of the Aztec Empire, based on traditional patrimonial rights and supported by a prebendal system of payment, not only by the internal requirements of the system. Adams has pointed out that in Mesoamerica ". . . the growth of social stratification seems to have been preeminently a politically induced process associated with royal largesse in the distribution of lands and tribute" (1966: 65-66). His analysis of the Empire is followed largely by our interpretation of the Cuicatec after Aztec conquest, but not before it. Traditionally, the Cuicatec elite was primarily supported in power by its own role and function in the division of labor of the society.

Attempts to manipulate cacique and community rights were common under the Colonial regime, especially in the initial period, because old rivalries could become "legal claims," due to the conquerors' ignorance of local conditions. Numerous conflicts over succession rights, boundaries, etc. ensued soon after the beginning of the Colonial era; our 1562 document is a good example of the problems the Spaniards had to face. But, without a trustful and knowledgeable bureaucracy of their own men, the Spaniards could hardly afford not to maintain temporarily the local arrangements. Supporting the local rulers insured the Spaniards against local revolts; it was to the local rulers' advantage to remain loyal to the crown for otherwise they would have lost their privileges. In addition, the Spaniards imposed local peace. Thus a continuous flow of local tribute from communities peacefully engaged under cacique control in the business of creating economic surplus for their conquerors was insured. Both the Aztec and Spaniards, by establishing as administrators an already existing local ruling group, and imposing a forced peace, served to maintain the existence of the established organization and freeze the natural evolution of the Cuicatec socio-political system. Changes since then are the result of new external variables entering the native society.

Through time, the Spaniards implanted on the native social system their own economic and political hierarchy, with their own managers, civil servants, and religious and military personnel on top. This not only interrupted the consolidation of possible expanding political units, above the existing local cabecera levels, but divested the native political figures of the basis of their power. The native upper class was practically abolished by a number of Spanish innovations. With the introduction of Christianity, they took away from the cacique class the control of religious institutions. With pacification they denied the military basis of the local rulers' power. In addition, the later replacement of local aristocrats by their own civil servants, corregidores, encomienda grants, reallocation of land control on community ayuntamientos or Repúblicas de Indios, and appropriation of the best irrigable lands for Spanish-inhabited settlements removed all important political functions from the native group.

Indian Revolts and the Big Change

When the local Cuicatec elites perceived the series of moves to restrict their powers, they apparently attempted to rebel, as did other Indian groups sooner or later (Cline 1966). But it was too late. Juan Gaitan, Cuicatec cacique of Papalo between 1578 and 1590, and one of the informants who helped write the Relación de Cuicatlan (1580), was given a cacique tasación in 1578. In 1583 and 1590 he was recorded as being in charge of making the land settlements with the principales of Papalo and Tepeucila. But in 1592 he attempted a revolt with the popular support of other Indians, was then exiled locally, and in 1594 was ordered to appear in court to be tried (AGN, Ramo de Indios: Vol. 1, Exp. 162; Vol. 2, Exp. 757; Vol. 3, Exp. 80, 81; Vol. 6, Exp. 803; [Second Part], 339, 660, 752). Future work may elucidate the specific nature of these revolts. In the period 1590-1620 the Spaniards reduced the economic value and political prestige of cacique positions by instituting elections, disregarding native preferences, shortening cacique title and the tenure of other officerships such as governors to periods such as a year, and suspending the granting of cacicazgo privileges. The last privilege given to a Cuicatec aristocrat and recorded in the AGN was in 1618. Also in 1618, the corregidor granted the Governorship of Papalo against Indian election results, and at least four Indian caciques were imprisoned or tried between 1591 and 1618 (AGN, Ramo de Indios: Vol. 2, Exp. 800; Vol. 3, Exp. 909; Vol. 6, Exp. 1182; [Second Part], Exp. 56, 660; Vol. 7, Exp. 131, 285, 348).

With the social death of the Cuicatec aristocracy in the early seventeenth century, and with the increased number of local Spanish settlers, the cabeceras of the wealthier cacicazgos in the Cañada became Spanish-dominated and soon encroached upon irrigated Indian lands. This continued throughout the eighteenth and nineteenth centuries until Indians in the Cañada became marginal as a population group (AGN, Ramo de Tierras: Vol. 742, Exp. 4; Vol. 789, Exp. 4; Vol. 1206, 1273; Vol. 1715, Exp. 3; Ramo Mercedes: Vol. 22; Vol. 81). These settlements are all today basically Mestizo. In the interior mountain cacicazgos, however, which were poorer, less acculturated, not as well communicated, less attractive to Spanish settlers and hence politically more autonomous, Indians have maintained some degree of sovereignity to the present time, even though the nobility did not hold its ground. Papalo became part of an Alcaldía Mayor under Teutila and became an encomienda from 1589 until about 1597. Cuicatlan and Atlatlauca were, from the beginning, corregimientos and under royal control (except that half of Atlatlauca which was granted as encomienda to a local corregidor). The mountain communities became politically dependent on the Cañada, controlled by those cabeceras of Spanish settlers in the Cañada that had now become Spanish towns (*ENE*, VI: 57-59, 150-179; IX: 43-49; XIII: 3-46; XIV: 70-101, 122-139; R. de O.: 74, 83-84, 93, 96; Icaza 1925: 506, 116, 198, 916). Two sugar cane haciendas were also established early in the Cañada (Martinez Gracida 1883; Osorio 1959 unpublished).

This situation gives shape to the affairs of the present century. But is is important to note that even today it is the mountain Indian communities, such as Concepción Papalo, that were in the sixteenth century cacicazgo capitals and that have maintained their rights on irrigable lands. They are not only the wealthier more internally stratified and more acculturated of Cuicatec Indian municipios, but also had been the most successful in utilizing pressure against the Mestizos from the Cañada, who politically control the region, to obtain economic aid and special privileges from the state and federal governments. Concepción, the Papalo headtown which recovered all lands lost to the hands of local District chiefs in the Porfirian era, is the only village with a dry-weather improved road passable by motor vehicles. Also, it has obtained a large government contract to sell its wood to a national paper company in exchange for conservation, replanting, and erosion prevention work, plus a sizable income for the local municipio. They also have the best local school, staffed by three teachers, and the highest levels of Hispanization and literacy. This community has managed to control, within the municipio boundaries, the largest number of politically dependent settlements (rancherías and agencias municipales). In fact, while many Indian cacicazgos of Mexico lost most of their subject barrios and haciendas when they formed independent municipios, the irrigated and relatively wealthier community of Concepción Papalo still preserves under its control most of the territory it controlled at the time of the Conquest.

If our interpretation is correct, the Cuicatec situation may prove to be similar to that of the more populous villages and "urbanized" settlements of the intensively irrigated Tehuacan Valley and parts of the irrigated areas of Puebla and Morelos, at Conquest time. It would be necessary to continue the research on into more recent times, both in the Cañada and in Tehuacan, following the work done by MacNeish in the lower archaeological levels. For Postclassic and contact times in Tehuacan, where ethnohistorical documentation in the AGN is abundant, especially in reference to irrigation, the combined efforts of ethnohistorian and archaeologist may finally solve some of the basic problems attached to our general interests.

The duality of organizational principles on which Cuicatec states were built and their schismogenetic nature has remained, in spite of the changing political scene for Mexico as a whole, the core of the present-day Cuicatec municipal system. Territorially, of course, the two main ecological and economic supports have not changed greatly; that is, the available water supply and distribution of basic staple crops and technology have remained the same. Neither have some others. For example, there are no modern roads or highways anywhere in the District and major dry-weather routes are pre-Hispanic in origin.

It is hard to make a sure evaluation of kinship and descent. Ambilateral, localized kin groups still exist among the Cuicatecs, and appear to be old structural blocks. What is striking, however, is that the present-day Mexican ruling class in the Cuicatec district traces ambilateral descent, however fictional it may be, either to members of the Indian nobility of pre-Hispanic times or to Spanish political officers of the Colonial Period. This present-day ruling elite also defines itself as a descent group, loosely tying together potentially antagonistic towns and villages through intermarriage and kinship. In addition, through control of the PRI party and commerce, they tie the district to the political and trade centers of the nation. They control not only the administration of water but also the best lands for cultivation, credit, trade, and politics at the village, town, municipal, and district levels. Their identification with past ruling groups in terms of descent does not seem accidental. Modern caciques have learned, if nothing else, the long historical lesson.

Summary and Analysis

In previous sections we have attempted to reconstruct the general character of Cuicatec society about the time of the Conquest, without placing it in the larger context of Mesoamerica, unless specifically relevant, and without reference to problems of more than local reconstruction. This has been a restriction consciously imposed for two reasons: (a) to avoid overgeneralizing either from or to the Cuicatec from data which either belong to different periods or areas or are of different levels of abstraction; and (b) to present our evidence as uncluttered with general theory as possible.

Now two tasks remain: first, to summarize our evidence and second, to place it in the proper analytic perspective. Ethnohistorical materials without archaeological backing are only of minor use in reconstructing evolutionary trends, primarily because they deal with a narrower span of time, and also because they are, by the nature of historical documentation, only accidentally relevant to specific problems. Hence, this analysis is only a tentative picture.

The region of Mexico between the Rio Usila, Rio Grande, Rio Santo Domingo, and the northern end of the Rio Vueltas was occupied, before the Spanish Conquest, primarily by Cuicatec speakers. These were organized into small independent states with settled "urbanized" villages and towns, and the people were engaged primarily in agricultural subsistence activities based on intensive irrigation.

At the time of the Conquest all irrigated niches in the immediate region were controlled by permanent communities of Cuicatec speakers, except for the north tip which was under Mazatec control. Adjacent regions to the west, east, and south did not practice intensive irrigation, either because of ecological restrictions, due to mountainous land and lack of sufficient water sources, or because climatic and soil conditions did not favor this technique (for example, a tropical rain forest with moist soils).

The Cuicatec states occupied two distinct ecological niches. One was the Cañada de Cuicatlan on the Rio Grande, the other the mountain region east of the Cañada. All settlements were located adjacent to water courses. In the Cañada, house-sites were placed on the spurs and slopes of small hills below the Cañada wall on small alluvial fans of permanent tributaries to the Rio Grande. These sites were located at altitudes between 550 and 650 meters above sea level. Elsewhere the canyon was uninhabited and unimproved. A strip of unoccupied, semi-arid, mountainous land separated these communities from the ones in the mountainous flanks to the east. A second type of Cuicatec settlement, at altitudes of 1,500 to 2,000 meters above sea level, formed a mountainous belt circling an uninhabited Central Massif. These settlements also were located in association with streams used for irrigation. Even though it was and is possible to maintain permanent settlements by means of an agriculture based on seasonal rain, irrigation is highly advantageous because this mountain flank is located in the rain shadow from the Gulf of Mexico and rain is unpredictable and often insufficient. The settlements in this belt used an outfield-infield system of cultivation, with intensive irrigation in scattered small niches of favorable geographical conditions. In the Cañada, however, agriculture was practiced solely on the basis of permanent irrigation because the extreme climatic conditions do not permit agriculture dependent on seasonal rain. Without irrigation, the area is capable only of supporting hunters and gatherers. Irrigated niches in the Cañada were much larger than their mountain counterparts, but were restricted to the small oases around affluent streams with alluvial fans. Irrigation canals were built along the edges and across the fans and at some locations were extended beyond the limits of the fans to irrigate the narrow terraces bordering the main river. The location of springs, small tributary rivers, and other permanent or seasonal sources of water, as well as the scarcity of water available for irrigation, was a major variable in determining the location of human habitation and the interrelations between social units.

The distribution of human settlements also seems to have been related to population pressures and defensive tactics necessary to protect the irrigable land and scarce water resources. This seems clearly the case in more recent histories of community fission and political-territorial separation, where documentation is more reliable. For the period under discussion we have only one well documented case, that of Yepaltepec-Papalo. Scarcity of water sources has to be understood in this context as culturally-defined scarcity, given the needs of a small intensive irrigation system, and not in absolute terms. In the same sense, population pressure here is implied to mean ratios of cultivators to area of available land that is or can be irrigated. Our later, post-Colonial, historical cases follow extraordinarily similar lines. In the case of San Miguel Santa Flor, for example, for which population figures since the mid-nineteenth century are available, it becomes clear that it is Cuyamecalco, a community in the town having a high population density, that moved over the frontier, invaded adjacent land, and finally divided into two separate political units, so that at the present time, approximately eighty years after the initiation of the exodus, population distribution has been balanced and stabilized over the territory in question.

Those Cuicatec settlements which used irrigation had been located in positions of strategic value for irrigated agriculture and the protection of water sources and canals from outside invasion. Therefore it is not unreasonable to suggest that the initial introduction of irrigation into the area must have been a crucial factor in determining the settlement pattern which has been maintained up to the present time. The remarkable stability of Cuicatec settlements seems also related to the presence of permanent water sources for irrigation. The neighboring Chinantec to the east, who cultivate tropical lowlands, have, on the contrary, a marked history of shifting communities and resettlement over relatively short periods of time, both in pre-Hispanic and post-Conquest periods (Cline 1961). Within this small area of northeastern Oaxaca, then, one can exemplify the marked differences in settlement pattern and endurance of nucleated urbanized villages, differences which archaeologists have suggested existed between the highlands and lowlands of Mesoamerica, and which Linton presented as an hypothesis many years ago (1962: 32-40).

The permanent settlements of the Cuicatec, ranging from small hamlets to semi-urbanized towns, were not single village-community societies. Usually several were linked into a small state containing settlements of various sizes. These were arranged in a pattern with a nucleated town as a central capital and peripheral rings of smaller subject villages and hamlets within walking distances of twelve hours or less. From evidence in one well-documented case, it appears that these smaller settlements were offshoots of the oldest and largest community; that is, they were founded by colonists who had moved from the mother village at different periods, to open new territory, or to locate new settlements at strategic points in the territory already under control. This supports Willey's hypothesis concerning the hiving off of village centers into daughter communities in Mesoamerica in general (Willey, Ekholm, and Millon 1964: 489). The rings of communities were politically subject to the oldest and largest town, the *tecpan* or cabecera, where the government apparatus was located.

With the exception of Malinaltepec, a Chinantec-speaking vallage, all towns subject to Cuicatec cabeceras were inhabited by Cuicatec speakers. However, areas along the frontiers were ethnically and linguistically mixed. Language frontiers have not been matched by cultural or social frontiers. In fact, the corner of Oaxaca containing the Cuicatec, especially the interconnected canyons and valleys of the Rios Grande, Salado, and Santo Domingo, resemble the European Caucasus corridor in its linguistic heterogeneity. Cuicatec, Ixcatec, Chocho-Popoloca, Mazatec, Mixtec, Chinantec, Zapotec, and Nahuatl languages are all represented. Of these, only the first two are primarily located here. The others have their primary geographical extension somewhere else. Dialectally the area is still infinitely more complicated, and it is possible that many of these dialectal variations are, in fact, distinct language groups. It is probable, as the mythology of Mesoamerica and Oaxaca in particular tends to suggest, that this region had been a cultural passageway in prehistoric times, both between lowland Veracruz and highland Oaxaca-Puebla, and among the intermontain valleys in the highlands, especially the Oaxaca-Cañada-Tehuacan-Cholula-Valley of Mexico chain.

The frontier heterogeneity was reflected in the political networks about 1580. Quiotepec, a Mazatec town in the Cañada, had for historical reasons been partially controlled by a Cuicatec ruler. A few Cuicatec settlements in the southwest were attached to Mixtec rather than Cuicatec states, for example, Tonaltepec and Tutepetongo to the Mixtec cacicazgo of Huautla. It was probably as a result of earlier Mixtec tribute-collecting wars before the Aztec invasion that these communities did not belong to Cuicatec rulers. The Cuicatec themselves did not tend to acquire subjects by conquest. On the contrary, they seem to have been regularly engaged in a defensive warfare to protect their valuable land and water from encroachment by less favorably located neighbors. On the borders some states had absorbed and ruled politically enemy territory, or vice versa.

The mountain and Cañada Cuicatec states were significantly different. Those in the canyon had relatively smaller territories with higher population densities. The mountain states had larger territories with lower densities of population and were poorer and less stratified. Population distributions for later periods seem to point to ecological-technological origins for this difference. Populations were and are concentrated in the niches in which the most efficient returns on agricultural activities can be obtained. Since the highland states were dependent on seasonal rain for part of their crops, yields were smaller, and a smaller population spread over a larger territory adjusted itself to deficiencies in technology, land quality, and water shortage. The same distributions appear today. In times of drought, the mountain states have always depended on the Cañada towns for survival, exchanging staple surpluses for migrant labor in the Cañada's irrigated fields.

We are not certain what kind of political subordination followed in the wake of these exchanges. Today, the Cañada dominates the mountain towns. From one point of view, the mountain communities had advantages over the Cañada in that they controlled several water sources upon which the Cañada depended for its irrigated fields. Because of this it could be expected that the mountain states were able to control politically those below them who depended on their water supply. This was the case in the Papalo-Quiotepec arrangements which have continued until the present; at least water taxation is still paid to Papalo. However, the Cañada states were wealthier, had better communications with the outside world, and, as far as our evidence goes, were less "rural" than their mountain counterparts. Their political and military might and their increased opportunity to reach the outside world may have sufficiently compensated for their less privileged location in regard to water sources. Thus, the Cañada state cabeceras seem clearly to have been more "powerful" than their mountain counterparts, and managed their affairs in such a way that water control remained in their hands. Atlatlauca had its own source of water and controlled politically all its mountain settlements. In the Papalo-Cuicatlan case, even though Papalo had within its territory the major source of water for Cuicatlan, Cuicatlan was politically independent if not superior. At the present time, Cuicatlan in the Cañada is the dominant political center of the region, and in times of water shortage Papalo, without payment, is forced to reduce its water consumption to allow for the deficit in the Cañada settlement. It is hypothetically possible that, relative to irrigation, downstream Cuicatlan was dominant because it had initiated the process of traditional establishment of rules for the regulation of water. T. Glick (1970) has shown that in Valencia, downstream communities had stronger positions in the administration of water for irrigation because it was to their advantage to develop and administer irrigation legal codes. Since they had been instrumental in the original establishment of an administrative system of water control, they had reserved to themselves a position of privilege in water allocation rights.

It seems, therefore, that geographical advantages with respect to water sources played a political or economic role only when the rival populations were of approximate equal size and of equal political or military might. These advantages were nil in cases in which population size, military might, or other factors favored the communities that did not control springs. It is possible that the states in the Cañada, about the time of the Conquest, also relied on help or support from the Aztecs in quelling rebellion in the mountain towns. In later historical periods, the use of federal troops by the Cañada towns to maintain peace in the mountain hinterland seems to follow the same pattern.

Each Cuicatec micro-state was a small political aggregate, extended to the viable ecological limits of expansion. The polity was economically organized on the basis of water control, irrigation agriculture, simple technology, local markets, a regional tribute network, short-lived warfare, and on the absence of means of transport other than human. Although marginal lands were exploited for gathering wild products, collecting firewood, establishing nopaleras, and so forth, the limits of the potentially controllable irrigated territory, and in the highlands the lands enjoying seasonal rain, established the political frontiers of each primitive state. Ecological marginality did not favor the technological expansion of irrigation into large hydraulic systems; hence, the viable unit of political integration was small. That is, political centralization at a higher level of integration was apparently not viable under these technological conditions; conditions which imply instead political and territorial autonomy of relatively small and centripetally-oriented human aggregates.

Schismogenesis operated at all levels of integration within and outside the state boundaries because, even within the political units small enough to be held together with primitive techniques of transportation, administrative recording, and warfare, the status of separately irrigated subject communities was unstable. Political schismogenesis and reintegration of frontier settlements was a permanent condition of the local socio-political structure and, moreover, it was present at the macro-levels. Whatever small sense of common political unity the Cuicatec language group had as a whole was based on other, extraneous factors.

One source of reintegration and stability was at the level of the ruling groups. The upper classes had a more "international" outlook, and their class interests and intermarriage practices overrode ethnic and local loyalties and prevented internal warfare. Both processes of fission and fusion were interrupted by the Aztec conquest ca. 1510 which imposed continuity on a previously fluid political arrangement.

The Cuicatec formed, as far as can be determined, a symbiotic economic and ceremonial province of both Cañada and mountain states, and a political community maintaining peaceful internal exchanges, unified by language and integrated at the upper-class level by frequent intermarriages between members of the ruling classes of the different states. There is no evidence that this province was a political unit in a formal sense, a "confederacy," alliance, or analogous unit, or that the small independent states were subordinated to each other in any sort of formal ranked arrangement. Communities, mostly towns of rulers and hamlets of cultivators, were politically ranked only within states. However, in territorially-bound units a more complex division of labor was clearly emerging. Contemporary local legend points to Cuicatlan as the "capital" of the whole Cuicatec; but we believe this myth to have grown in post-Colonial times because there is no documentary evidence to support it. Each one of the Cuicatec state governments was an autonomous small unit, subordinated only in the late times to the Aztec rulers. Apparently, however, language, cultural similarity, shared boundaries, local trade and marketing, and upper class intermarriage served at the time to maintain multiple peaceful exchanges among the feudal states inside the language group, while hostile relations obtained outside it, i.e., with states of speakers of other languages. We use the term "feudal" here deliberately, following Sjoberg's model (1952) which we strongly support because it is applicable to Mesoamerica and to the Cuicatec in particular.

Conflict over water, however, appears to have been an endemic aspect of the political system, especially in pre-Hispanic times. In the Cuicatec cacicazgos, each settlement or community often controlled disagreements over cultivated fields and irrigation canals through intermarriage of "royal" lines. To solve such disagreements over frontier lands, bordering states were sporadically embroiled in warfare with non-Cuicatecs. After Spanish entry, however, when the local elites lost their power to regulate internal competition among their subjects, a multiplicity of court suits over water and boundaries flooded the Colonial bureaus. Descendant populations of pre-Hispanic settlements in the area are still involved in some of the same conflicts which flare up, especially in dry years, and remain dormant, unsolved conflicts the rest of the time. Today, the Mexican state and federal governments are involved as mediators; this is also the case outside the Cuicatec, for example in Tehuacan, Mixquic, or Teotihuacan. But it would be a great error to assume that Mexican government agencies actually function by instituting controls above the local levels, or that an overly powerful centralized state organization outside the Cuicatec region was needed in pre-Hispanic times to accomplish the same conditions. Fernea (1963), Million (1962), Millon, Hall, and Diaz (1962), Palerm (1955), and ourselves here and there tend to treat contemporary or recent historical evidence as equivalent to or suggestive of previous historical situations. Fernea's references to the past are ambiguously unlimited in time; Millon's opinions only apply to the post-hacienda period, and ours jump from the sixteenth century to the present without documented transitional processes. When discussing social processes with a long history, the fallacy of the "contemporary ancestor" is an easy pitfall; each society, and each generation, may find highly different solutions to their conflicts, especially when different levels of socio-political structure and technology, political networks, and military might and strategy may have greatly changed in the interim due to other factors.

Today a national centralized government rules over all. Earlier, at the time when the Cuicatec region was opened to the Western world, the small warring independent states existed in a state of precarious balance. Traditional political means of maintaining this balance and repressing conflict were: water taxation, reallocation of prebendal rights to junior aristocratic lines, and culturally acceptable procedures for legitimizing traditional patrimonial rights. In addition to these were the demonstration of initial colonization of a territory, and the waging of successful short-lived wars with competitors. These latter were followed by long-term peace agreements contracted by local ruling elites and recorded in oral tradition and manuscripts.

It is unfortunate that, with some notable exceptions, most of the workers who have dedicated themselves to pre-Hispanic and Colonial codex materials have been so fascinated by the religious aspects and the mythology and have paid so little attention to the wealth of information on aspects of the social system, history, and secular affairs that the codices so often contain. As we pointed out above, at least two Cuicatec codices containing invaluable information on irrigation works and warfare are extant. Neither one of these has been fully studied, a task I plan to attempt in the future.

If both manuscript and codex materials had been searched for information concerning irrigation, for example, a large part of the controversy which flared up not long ago over the presence or absence of irrigation in Mexico outside the lake area would not have been necessary. Armillas's (1949) demonstration of the existence of irrigation in the Balsas region fortunately cleared up the issue long before the present work was begun. As Armillas pointed out, a large number of local irrigation networks were abandoned soon after the Conquest. His hypothesis that this was due primarily to the lack of labor produced by depopulation, is probably still the most plausible answer. However, there may have been another cause comprised of a combination of factors. After Spanish entry and the fall of the multiple small state governments, and with the failure of the Spanish bureaucracy to understand native irrigation conflicts and solve them in an acceptable traditional manner, the native mechanisms to administer water and regulate conflict may have broken down. The lack of suitable controls on the part of the Spanish conquerors may have made it impossible for local indigenous governments to resolve conflicts peacefully in the traditional manner. Furthermore, a reallocation of labor for tasks of more interest to the Spanish than irrigation works, may have added to a condition which resulted in the abandonment of many irrigation works. An additional factor may have been dessication of some regions, for example, the Mixteca Alta of Oaxaca, due to deforestation and overgrazing by introduced European sheep and goats.

Rights over water, as well as other economic and political rights were, among the Cuicatec, vested in corporations of peasants located in compact villages which controlled bounded territories. The lands for cultivation, however, within the corporate unit, were under individual, or family, usufruct for a period of one year of tenure, after which time parcels were redistributed by the state bureaucracy. Lands were also assigned for the support of the temples and the lords' households. In each settlement it was the task of the local rulers to redistribute and reassign individual plots. In exchange for services, which also included the collection of tribute, representation in the cabecera, etc., the local lords were given privileges and free labor on agricultural fields planted to support them by the commoners of the communities. These fields were not private property; they were attached to the office rather than to the individual. When a man resigned or abandoned his political role, he could not continue to enjoy the benefits of the official lands and other perquisites of his position. Inheritance of such rights was tied to actual succession to office, not to descent or personal property rights per se. However, caciques were selected from lines descending directly from those who were the leaders when the community was settled; nobility of lineage as well as political ability was prerequisite for the highest political roles. Thus, the agricultural activities of the peasant corporations were geared both to the subsistence needs of the resident commoners and to the creation of surplus to maintain a semi-absentee, descent-defined, political elite.

Unified under a state lord who governed from the capital, the elite of local lords ruled the state's subjects. Rights were vested in the class and not on individual personal claims, although single individual tenure acquired through legitimate succession was normative. However, rulers could not rent, sell, exchange, or otherwise dispose of the lands of the communities over which they governed. In a sense, these scarce tenure rights were de facto entailed, and could only be lost by the peasantry through forceful conquest. Otherwise the territory was a traditional patrimonial domain of the upper class group as a whole. It was the ruler's position and function in the community that created the platform upon which they built their authority and embroidered their privileges, but it was an historical tradition of "aristocratic leadership" (*señorío*) that granted them the power to provide rulers from their own descent group, and to train for such positions only those who were born within the class.

The traditional patrimonial rights to rule were determined by kinship and class. Although, under certain conditions, individual achievement of high rank was possible, e.g., army captains, these mechanisms were overshadowed by the ascriptive character of power legitimization. Up to the time of the Conquest, the functions of the elite were a monopoly, and the skills involved could only be acquired by those who had a right by birth to be trained into them. That is, with the exception of army officers, training was only received by descendants of the previous ruling generation. It is possible that the increasing importance of military activities for defense purposes might have, at the time, given initial impetus to a newly formed political "pressure group" of military men, recently incorporated into the elite. The Aztecs gave *tecuhtli* titles to some of the captains in the Cuicatec region. For example, the ruler of Tutepetongo, a Cuicatec estancia which had become a dependency of the Aztec garrison of Huautla (a Mixtec town), was a captain in the army of Moctezuma II. The significant role of warfare is clearly documented both directly and indirectly; participation in war was a source of political power. Caciques themselves, as well as appointed army captains, were responsible for the maintenance of territorial, economic, and political autonomy, and there is no doubt that these skills significantly fostered and enhanced their ability to continue in power, regardless of the manner in which their authority was originally acquired. The rulers, however, were primarily secular, separate from the military and the priesthood, at least nominally. Nevertheless, the aristocracy at the top of the Cuicatec social pyramid combined among its members the roles of administrative officials, priests, and army officers.

Which one of these quasi-groups was dominant seems uncertain. The jurisdictions of individuals were not clearly delimited, and personnel for some posts were apparently interchangeable. Moreover, the functions of the institutions were not markedly differentiated; for example, a priest dealt with strategics of warfare, political leaders were also army officers, and so forth. Archaeologists tend to see their evidence as indicating the dominance of one or another socio-cultural institution. Thus we speak of theocracies, militaristic states, and secular states as different types of social structures, as inferred from the archaeological, proto-historical records. To me it seems that, upon many occasions, it is difficult to determine the truth of such statements, and that such statements do not necessarily reflect a logical evolutionary scheme appropriate to the interpretation of Mesoamerica. First, the evidence is indirect, it consists of art records, the fortuitous discovery of weapons, trade ware, and so forth, in areas which have not been thoroughly excavated or for which nothing is known of adjacent hinterlands. Second, it seems that in Mesoamerican state systems, as in chiefdom-level societies, in the early stages of development there is a lack of functional specificity in the activities of the government apparatus. In Weberian terms, the state bureaucracy had not rationalized the division of labor so that no clear jurisdictional realms were systematically established to provide for distinct domains of decision-making and personnel recruitment. The Cuicatec case seems relevant here because of its provincial character and because it showed cultural lag in contrast to the more advanced, centrally located groups. The small ruling elite as a whole controlled not only the administration of land and waters, but trade, the ritual arranged in cyclical festivities which were timed with the extraction of tribute, the administration of the native church and its dogma, and the waging of war against non-Cuicatecs. All these activities formed part of a unitary government system, without a true separation of branches.

Posts in all the institutions were occupied by members of a single macro-descent group, a high-ranking ramage which was class endogamous and in which many privileges were exchangeable among the members. The dominance of any institutional domain at a particular time in history might have been due, not to any historical or evolutionary conditions exclusively, but rather to the personal skills of those leaders to manipulate power with the elite, to redistribute favors, and to maintain their popularity among the peasantry. In fact, it seems that it was the combination of monopolistic powers over military, economic, and religious social concerns simultaneously that gave the ruling elite its growing strength.

The record seems to suggest, however, that at the time of the Conquest, the priesthood as a group occupied a weaker position than did the secular rulers. The writer of the Relación de Atlatlauca claimed that "the dignity of priest was more than that of cacique" (*PNE*, IV: 167), but the evidence he gives is weak and contradicts his statements. His statement seems especially distorted because the ruling lord controlled appointments to the Church schools and to the priesthood's ranks. The priesthood itself was filled by lesser members of the nobility, whose tenures in the role were short (seven years) and who could be removed from office.

The pre-Hispanic picture is one in which the institutions of religion, war, and politics are closely tied together, and developmental trends in the dominance of one or another are extremely difficult to discern. The rise of militaristic gods such as Tezcatlipoca and Huitzilopochtli in Mesoamerica seems to be contemporaneous with the emergence of militaristic and expansive groups in the urban centers of the Valley of Mexico (cf. Lesur 1968). One, Tezcatlipoca, appears in a Cuicatec codex (Nicholson 1966) together with other pan-Mesoamerican gods. But what the Cuicatec gods were symbols of, which ones dominated each one of the local temple services, and so on, we can only make an educated guess. The gods that have survived among present Cuicatec Indians (both as folk "gods" and Church saint-names) all point to the importance of water, agricultural, and domestic deities. Paramount among them are Tlaloc, in the form of lightning and residing in the Cuicatec hilltops, Chalchihuitlicue, and the goddesses of sustenance and the homestead, the three stones of the household hearth, including also Chantico and Mayauel. These were and continue to be the deities most significant for the peasantry, but to take them as the most important deities of pre-Conquest time would be a gross error. When organized Cuicatec religion collapsed with the Conquest, the gods of the urbanized elites, e.g., some astronomical symbols, rapidly faded away, and only those gods cherished by the rural masses were kept on in folk tradition, surviving the ravages of time and Christian conversion. Their endurance does not necessarily point to a previous state of superiority in the pantheon.

A significant new bit of evidence concerning social stratification levels achieved by some Mesoamerican groups is the discovery that the Cuicatec had a stable mechanism for land redistribution. It is probable that land redistribution on a yearly basis served to promote economic homogeneity and dependency at the level of the peasantry, accompanied as it was by recurrent tribute extraction and labor-in-services which impeded, or at least slowed down, the accumulation of capital among commoners. Both these practices, in the long run, seem to have functioned against the diversification of the class system into a highly stratified structure, but they did provide the administrators of the system with the power to maintain through time a clear rank distinction between themselves and the mass of the governed. The levels of rank were explicit; one was or was not a nobleman, and the criteria of "belonging" were clear cut. Thus, at the time of the Conquest, we see Cuicatec society as stratified into two macro-classes with distinct occupational groups, and as having risen above the chiefdom level of social organization. (Cf. Service 1962 for a definition of the contrast between chiefdom and state.)

Several crucial factors allow us to classify the Cuicatec polity as an incipient state system: the presence of social classes; occupational groups of a secular character; a permanent, although not elaborate, bureaucracy; a state church with a regularly professionally trained clergy; an organization of ranked army officerships; urbanization; markets functioning outside a redistributing economic network; a territorial arrangement of higher and lower political units, and so on. However, we hesitate to call the Cuicatec state "city-states" for two reasons: first, political secularization, stratification complexity, centralization of state powers and urbanization are distinct processes, however linked they may be historically; and second, the nucleated headtowns of the Cuicatec were urban only in terms of their local importance. Their size was quite small compared with the large urban centers of the Classic and Postclassic periods of the valleys of Oaxaca, Mexico, and Teotihuacan. Although they had their share of monumental architecture, such as ball courts and temples, and urban improvements, such as elaborate luxury housing, they were relatively rural. From a larger world perspective, they seem to be more like the developments in Early Dynastic Mesopotamia than the contemporary developments in the Valley of Mexico (Adams 1960:8). The terms "village-states," "town-states," and "micro-states" have been used in the preceding descriptive sections. However, and this is in accord with our second reason above to mistrust the use of the standard terminology, the populations of the Cuicatec states were not all concentrated into single walled settlements, but scattered about the landscape in small nucleated localities. On the other hand, the stability and concentration of local settlements and their political continuity, the relative dependence of the subject communities, and the presence of secular public buildings within the nucleated settlements excludes the possibility of classifying them as purely "ceremonial centers." Moreover, it is apparent that a large percentage of the state's peasantry aside from traders, craftsmen, and so on, lived within the capital itself. A relative comparison would be to classify contemporary Chicago and a county town in Iowa as equivalent "cities." The Cuicatec city-states were, to say the least, behind the times. Spores (1967) prefers to call such states among the Mixtec "community kingdoms." Perhaps his terminology can be applied to the Cuicatec. We have been reluctant to do so in spite of the attraction of unifying the over-diversified terminology. Our reluctance is due to the use of the word "kingdom." The Cuicatec rulers were "lords" (*tecuhtli*) rather than "kings" (*tlatoani*) and use of the word would blur the distinction between a true monarchy of the Aztec type and a petty feudal lord. If Spores's terminology were accepted we would be required to distinguish between community kingdoms, middle-range kingdoms, and federative monarchies, and their structural differences would have to be specified.

From our point of view, the most interesting aspect of the Cuicatec socio-political system is the way in which territorial and kinship principles are combined for stable continuity. Since the time of Morgan and Maine, evolutionarily-inclined anthropologists have tended to view kinship and territoriality as divergent principles of social organization, sequential in terms of evolutionary lines, and have emphasized either one or the other in their model building. There is evidence, however, that both forms of arrangement may coexist in stability over long periods of time at different levels of the same structure. Even the Nuer, a classical example of a "kinship ordered society," classify their patrilineages according to territorial location as well as descent distance (Evans-Pritchard 1940). It is evident, now, that the Mesoamerican societies were organized into social nuclei which were neither purely localized kinship or descent groups nor purely state territorial or local units, but both. The classical example, of course, is the *calpul* which Kirchhoff (1955) calls a conical clan system, and which in the most recent dialect coined by anthropologists, would be a ranked ramage system (Sahlins 1958: Murdock 1960). This organizational model seems to have worked, with some modifications, for the Cuicatec as well. The Cuicatec elite was a defined descent group, all evidence indicating that it was ambilateral rather than unilineal, and it was divided into ranked minor ramages. Three levels existed within the aristocracy: a royal house, a specific descent line from which the overlords were chosen; junior and cadet branches which ruled over subject settlements; and the collateral lines which could not succeed to lordly positions, but intermarried freely within the elite and occupied the lower political, military, and administrative posts. The major political figures emerged from the royal house. It is dubious, however, that they were true "kings" equivalent to the Aztec *tlatoani*. With the possible exception of the Atlatlauca description, they appear as petty feudal lords rather than as kings. The name the Aztecs gave them, *tecuhtli* (lord, magistrate), seems to confirm their lesser rank compared with the institution of Mexica kingship, that is, the *tecuhtli* was not a *tlatoani*. Of course, the Aztecs may have just been ethnocentric about it. But in either case, it is clear that the rank of the rulers as a kinship group, in toto, was superior to the descent units of the commoners.

The elite ramages, however, were class endogamous but not ethnically or territorially endogamous. The minimum ramages appear to have been exogamous, and it was the class or the whole macro-descent group that was endogamous, for legitimate marriage. The Cuicatec rulers could and did marry across ethnic lines, and such marriages with members of the political elites of nearby "foreign" states were legitimate and permissible in terms of succession rights as long as the rule of class endogamy was maintained. Thus, kinship and descent was, in overall terms, of lesser importance than class affiliation. Recruitment into class membership was through the idiom of kinship; however, succession was bound to the territory of particular states because local residence, as well as legitimate descent, was a prerequisite for succession and the maintenance of ruling rights. Cuicatec rulers arranged marriages and distibuted prerogatives among their children much in the manner in which the European royalty of the eighteenth and nineteenth centuries married across national boundaries for political purposes. But, as was equally true in Europe, national or territorial interests of the state occasionally overrode affinal or collateral kinship links, and there was a constant interplay between both sets of loyalties.

The kinship organization of the elite, which seems to have been the same as that of Mixtec and Mazatec state rulers with whom the Cuicatec intermarried, is suggestive of a modified *calpul*-type organization, that is, non-localized ambilateral descent groups. To verify this hypothesis, however, data would be needed on the commoner classes which comprised the mass of the Cuicatec. Within the lower class or estate were three differentiated ranks. The bulk of the population was a free peasantry, probably residing permanently in the corporate village communities. We do not have evidence on their kinship organization and, since they were relatively free to move around, it is difficult to determine to what extent endogamy of the local community was or was not the norm. Moreover, the sources are silent on the matter of descent. As with many other societies and other historical periods, we know a great deal more about the elites who left us records of their affairs than we do about the silent masses of the people. Above the free peasantry was a small number of commoner administrators, *tequitlatos*. These were the link in the power chain between the rulers and the local peasantry. Below the free peasants, at least in Atlatlauca, existed a lower group of slaves. Information on this group is not clear enough to determine what their social origin and function was, except that some of them, called slaves, were in fact not a social group but rather prisoners of war, and some became religious sacrificial victims. Although we have both direct and indirect evidence that, among the commoners, craft specialists existed, we do not know whether these professions were formally recognized or ranked, nor do we know where the specialists stood as a group in the hierarchy of rank within the commoner class.

We have explained that two macro-social classes existed, each internally subdivided, and differentiated from each other in kinship and descent, in marriage links, style of life, activities and occupations, and ability to monopolize economic, religious, and political resources. That is, they were two distinct economic, cultural, and social groupings. The kinship base united by marriage regulations separated the population into two distinct groups composing two separate social macro-classes. These and local territorial cleavages perpetuated their unequal social positions through the idiom of descent. And it was through the ranking of descent lines and the nesting of local units on the ground that vertical as well as horizontal divisions were maintained in the society and that political links outside the local territorial groups were created.

From our data it appears highly probable that the ramages controlling the political life of the Cuicatec at the time of Spanish entry were descendants of a foreign group which imposed itself on a pre-existing social order. The dynasties known to us point to the local emergence of these groups approximately at the time of the political disintegration of Tula; other historical and mythological sources tend to coincide in such tentative datings. The Papalo dynasty claimed to have migrated from Amecameca. This implies that the political order in existence just prior to Aztec conquest had been diffused by migrants from the regions of higher civilization and social complexity of the valleys of Mexico and Puebla-Cholula. We want to make clear, however, that claiming migration of foreign rulers and populations is a poor way to understand the evolution of the social structure of a group. Lewis R. Binford, in an angry but highly lucid argument, made this point clear (1968: 265-275). Herbert S. Lewis had also discussed the topic in the context of historical analysis and cultural evolution of Africa (1967). His argument applies equally well to the political evolution of Mesoamerican states if we read "state" for his "kingdom": "Given the presence of one kingdom in an area, there are many ways of extending the monarchical form of political organization. Established kingdoms constantly expand their borders to control their neighbors (generally regardless of the ethnic affiliation of those neighbors). Alternately, tributary states, provinces, princes and successful generals frequently rebel, breaking off to create new polities when they succeed. Evidently, non-monarchically organized peoples, in the process of fighting against neighboring kingdoms, sometimes develop leaders with administrative staff that can establish new political hierarchies, with or without conquest of others. And some groups do conquer established monarchies or non-monarchical neighbors. The expansion and multiplication of states seems to be a constant process in history, but it is clear that this process need not regularly involve conquest by ethnically and culturally foreign peoples." (*op. cit.*, 37)

In this case we have historical documentation that strongly suggests the migration of, or conquest by, foreign, immigrant rulers, but this does not imply that the sources of power and legitimization of authority of this elite, once in existence, were purely external to the system. On the contrary, the basis for political legitimization of the Cuicatec ruling groups was internal to the society as it was developed at the time, and the rulers were, by the beginning of the sixteenth century, a truly Cuicatec aristocracy.

The evidence is logically congruent with the social demands of a growing population in an agriculturally based system practicing irrigation; and with other evidence from other areas of Mexico which, at the time of the Conquest, practiced irrigation and were in similar stages of development, such as the region of Colima (Sauer 1948). Hence, whatever the ethnic origin of the Cuicatec ruling dynasties may have been in the past, at the time covered in this work they were definitely a native ruling class which derived its power from successful functional adaptation to general social and cultural demands. In contrast with the central valleys the Cuicatec were less complex in their structural arrangements, probably because the universal technology of Mesoamerica in which they shared was coupled with a lower ecological potential. It is also possible that the Cuicatec became state-organized only under the impetus of structural changes occurring outside of the Cuicatec region in the key nuclear areas. Isolated, and without influences from Monte Alban, Teotitlan del Camino, Cholula, etc., they might never have developed a polity with anything more than a vague sense of tribal integration, the loci of which would be villages of speakers of a common tongue. However, by stimulus diffusion and contact with more evolved outside groups, they developed the multi-headed state system extant at the time of the Conquest. The fact that this system was precariously maintained through time suggests that, in the Cuicatec region, the state was not a strongly viable evolutionary development. It clearly was so, however, in the nuclear key areas where the ecological potential made its development a greater possibility, even with the same basic technology.

Using a finer grid of comparison, we see the internal ecological differences of the Cuicatec as significant in terms of evolutionary development. The highland cacicazgos, with a narrower range of surplus, an infield-outfield system of cultivation, and low productivity of staple crops, were politically not as complex in structure as the canyon cacicazgos. The latter had a larger spectrum of specialized crops cultivated solely by irrigation and a much greater productivity per hectare, when compared with the highlands.

In sum, the source of the local political power of the elite was in their ability to monopolize necessary organizational roles in land reallocation, water distribution and taxation, decision-making on communal labor, control of trade, salt works, and temple activities, and leadership in defensive warfare. These were the major threads with which they wove their net of class prerogatives and personal privileges. The peasantry based their group identity on language commonality and territoriality, and perhaps on endogamous, ambilateral descent groups of the *calpul* type. That is, for the masses, it was the local community, probably tied together by kinship, that served as the locus of identification with a socio-political unit. Neither a macro-Cuicatec state nor the Aztec Empire could claim their immediate or ultimate loyalty. Interaction with like units, for example in economic exchange, as well as peaceful relations, came about through the activities of their leaders. It was the task of this ruling class to integrate disparate local interests, a function which they could fulfill because their internal class loyalties overrode ethnic and local identities. On the strength of this they thus managed to extract from the ruled the legitimization of their position. It is only at the level of the ruling groups that the micro-states became partially interlocked and symbolically merged into an incipient Cuicatec province. This comprised the limits of the political community, which never fully developed, and which was later incorporated into the Mexica-Colhua empire. (For a definition of political community, see Swartz, Turner, and Tuden 1966). Skills such as the ability to read in order to keep records, so carefully protected as a class monopoly, gave them the access to resources which they perpetuated until Colonial times.

The maintenance of privilege within the class was also promoted by the control of the repressive religious apparatus involving human sacrifice and by the elaborate succession rules and regulations controlling the power vested in individuals. The rules of succession included the separation of legitimate and illegitimate, as well as collateral lines from cacicazgo rights. However, perhaps with the exception of Atlatlauca, multiple succession regulations served as a source of friction between lines of nobility, so that territorial units and factions were politically divided and dovetailed along descent lines as well as on the ground. Their inability to centralize power by viable succession laws was a handicap in that it hindered the development of more complex forms of stratification at the local level as well as the attempts of the elite to create a full-blown Cuicatec state. This latter would have meant at least the significant political integration of the whole language group.

However, single factors are never of themselves exclusive causes in the context of complex cultural situations. The ecological and technological bases of Cuicatec society also fostered schismogenesis; that is, the irrigation system had built-in sources of conflict as well as cohesion. This situation in which downstream and upstream communities shared scarce water supplies is, as we have documented, an historical one and not an isolated instance. Conflict over irrigation has persisted up to the present in most of irrigated highland Mesoamerica. Furthermore, it is not a peculiar ethnographic instance, but a structural factor also in other irrigated societies where scarce water resources, for one cause or another, can be monopolized. In the Cuicatec, as well as in other marginal irrigated niches of Mesoamerica, different cultural traditions adjust to these conditions in a manner which indicates that some of the same structural factors are in operation. Where irrigation networks are necessarily small or require only limited communal effort, cooperation in large scale may have been imposed from above and not come from within. We do not know, however, the sum of other possible ancient mechanisms by which cooperation was established in the past. Contemporary examples (Millon, Hall, and Diaz 1962; Palerm 1955; contemporary Cuicatec) are always suggestive but suffer from the false implication that previous historical periods were sociologically equivalent, an assumption not granted by the present state of the data we have to back up our theories of evolution.

The Cuicatec data, however, could suggest that small political aggregates above the chiefdom level could have been built on the basis of kinship and restricted intermarriage of the local politically dominant groups whose power emerged from the external and internal needs of an increasingly complex regional economic system. The class-defined endogamous political elite could surely have provided the initial social basis for the building of an incipient state apparatus. This is a luxury which can seldom be afforded by primitive agriculturalists, but which often accompanies more successful forms of agricultural exploitation such as irrigation. It is probable that the pre-Hispanic peasantry of the Cuicatecs, as well as of most of Mesoamerica, was locally endogamous, whereas the Cuicatec elite as well as other Mesoamerican ethnic elites was instead class endogamous. The elite of the Aztecs, as well as Tlaxcaltecans, Mixtecs, Tarascans, and others, for example, were very careful in selecting marital partners from the ruling houses of the most important towns in the Valley of Mexico and other conquered areas. This justified their historical "legitimate" claims to political leadership and it also provided a genealogical and political network through which to communicate decisions. It is in the context of an expanding "empire" built of small blocks of multiple micro-states that intermarriage between the Aztec nobles and those of conquered towns makes sense. The same of course can be applied to the Mixtec, Mazatec, and Cuicatec dynasties at the lower levels, and perhaps to the Zapotecs (cf. Spores 1964; Barlow 1962; Caso 1966).

Local exogamy and cross-ethnic intermarriage among the elite ramages may have developed as an institution to maintain an incipient class-descent group distinctiveness from the mass of commoners they controlled, and not because the elite consciously perceived this practice as a way of extending or centralizing power. But once in existence it could have functioned as a viable structural mechanism to do so, even if that was not its original defined aim. One would be hard put to justify the view that the Cuicatec masses saw any advantage to themselves in political centralization, or could derive any sense of common identity from the social exchanges of those who ruled over them. That is, there is no reasonable justification for believing that political amalgamation was perceived, outside the elite group, as an advantage or as "progress." However, among the Cuicatec the kinship idiom did not provide a solid ground for continuous action in the face of political rivalries between noble families which were isomorphous with territorial rivalries between communities. Added to these two disrupting factors, local migrations of an ever-expanding population and the irregular granting of prebendal rights outside exclusive descent lines, complicated the fluid picture. We do not know, for example, how often military leaders of commoner origin were allocated privileges among the Cuicatec, a practice which is documented for the Aztecs. We do not understand what the role of slaves in the Cuicatec class structure was, or to what degree traders, merchants, or craftsmen formed an independently ranked group, distinct from aristocrats and overlords.

Another crucial factor hindering centralization may have been the weakness resulting from the size and population densities of the Cuicatec states. Perhaps they had not reached the crucial potential threshold levels of population density-surplus ratios necessary to channel the group activities into the development of a complex urban state. In Durkheim's terms, they had not reached the level of "dynamic density" necessary for a complex division of labor at the political level (Durkheim 1883: 257). Both ecological marginality and agricultural and warfare techniques may have been responsible for this.

The Cuicatec system existing at the time of Spanish conquest was geared to function in small political aggregates. This promoted fission at higher levels by focusing political integration around the distribution in small niches of water, land, salt, and similar localized scarce resources. The states were arranged into a fragmentary organization, reinforced by language and other cultural differences among the masses. Thus, the largest unit in which loyalty of any sort was vested and in which war was avoided was the outer limit of the language group. Because of the weakness of these ties a true centralized macro-state could not be created. It was only by incorporation into the Aztec tribute network that the Cuicatec entered anything resembling a larger autonomous political system. It is possible, however, that their frontier position between the two centers of civilization of the valleys of Oaxaca and Puebla may have kept them politically independent of both in previous "archaeological" times. Or, it is more likely that they may have been subjects to the cultural influences and political ambitions of both these key areas alternately. The particular historical sequences of these developments cannot be discussed until future archaeological research solves the puzzle by determining outside cultural connections.

The system as it was before Aztec conquest had its functional strengths as well as weaknesses. A centralized political system would have created problems in the defense of a pre-Hispanic Cuicatec polity. With each micro-state basically autonomous from each other in resources and leaders, the fall of one important Cuicatec town into "foreign" hands did not make for the fall of the whole. Thus, the reduced capacity of expansion of the states may have also provided for the increased capacity to maintain political autonomy. One could argue that unified Cuicatec villages cooperating on a steady basis could have developed armies appropriate to the outside threats. This, however, misses the point that the geographical setting, the techniques of war, and the lack of rapid means of transport were not conducive to more than short-lived, localized warfare.

Even the militarily successful Aztecs obviously did not manage to maintain their budding "empire" exclusively on the basis of army strength. Although town-states continuously fell into the hands of the reigning Aztec kings, regular revolts of each ensued at different times. Frequently, the same towns were "conquered" in each successive generation and brought back under imperial control. It was the ability of the Aztec administration and local garrison officers, their multiple kinship connections with other ethnic elites, their extensive resources in the control of a complex system of trade and intelligence agents, their use of human sacrifice as a form of mass repression (and riot control?), and their skillful delegation of power through prebendal grants to regional political, military, and religious leaders which allowed them a degree of stable control in the face of recurrent military revolt of the subject towns. Moreover, the Aztecs relied on an elaborate division of labor based on much more extensive economic resources than did their provincial subjects, including high chinampa production and probably a surplus population. The provincial Cuicatec, however, seem to have been primarily and heavily rural. The people who were engaged purely in administration, trade, temple activities, or military policing were obviously small in numbers and relied primarily on the conversion of peasants into army recruits in times of stress. This arrangement, if involving the displacement of large numbers of cultivators from their agricultural activities, could not have been maintained on a regular basis without resulting in crop or food shortages. Such an army organization would have defeated its own goals.

We have some evidence that the way the system functioned actually fostered autonomy and strengthened the ability of the Cuicatec settlements to maintain autonomy. Both in the borderlands and in scattered islands in the northern interior, Mazatecs and Mixtecs had made territorial advances and settled their own populations in uninhabited Cuicatec territory. The daughter villages, separated from their mother settlements by lands belonging to Cuicatec states, had maintained their independence. The contemporary communities of Cuyamecalco and Sta. Ana, for example, were offshoots of the Mixtec state of Jocotipac, west of the Cañada, separated from it by the northern sector of the state of Papalo. There is no evidence that the migrants had interfered with Cuicatec internal arrangements. Even though the evidence is admittedly weak, our argument seems to explain why such finger-like or island-like colonizations were possible without disrupting Cuicatec political autonomy as a whole.

We suspect that the picture which emerges from close observation of the Cuicatec case may apply elsewhere in Mesoamerica. The central and southern highland region of Mesoamerica, excepting the latecomer "Aztec Empire," and the western-northern regions as far as Colima were divided into a mosaic of micro-states, the final result of the combination of multiple variables, which had local distributions due to ecological, economic, kinship, political, and other factors. To see the picture otherwise, to imply the dominance of any single factor, is naive as well as biased. Language commonality and cultural homogeneity probably acted to unify territories elsewhere as it did among the Cuicatec. But we hypothesize that economic control over a variety of scarce resources, only one of which was water, tended to produce endemic political fission which was not balanced by advances in technology, changes in the mode of production, or by more sophisticated means of reintegration at the political level.

At this point, one should ask what the relation is between this evidence and the questions regarding larger evolutionary trends in Mesoamerica, and in particular, what evaluation can be made of the role of irrigation in the socio-political picture. The first problem which comes to mind is, of course, Wittfogel's hypothesis. If I understand him correctly, the Cuicatec should be incorporated into the margins of a "loose hydraulic society" with its core in the lake area of the Valley of Mexico. This interpretation, of course, implies a priori that we are dealing with a macro-social system, that of the expanding Mexica-Colhua empire, or perhaps that of an even earlier Teotihuacan state.

Two immediate problems appear obvious to us in trying to accept this view. *First*, even though Mesoamerica was and could be said to be today a macro-cultural area, this does not necessarily imply that it contained a unified social or political system. Even as a cultural area it contained tribes of a "lower cultural level" in the interior of the territory (Kirchhoff 1952: 23); that is, it was quite remarkable for internal heterogeneity. Regional variation appears well documented both at the archaeological levels and in the contemporary descriptions of the early chroniclers. "Tribal" peoples, hunters and gatherers, chiefdoms, and independent state systems all coexisted side by side simultaneously. A variety of territorial arrangements, economic and kinship systems, political levels of development, degrees of incorporation into the "Empire," etc., existed at the time of entry of the Spanish, and the expanding groups from the Valley of Mexico were barely into the early stages of carving out anything resembling a unified or centralized socio-political system. Only a great stretch of the imagination would allow one to think of a single macro-state dominating the area ca. 1519. *Second*, a close look at the individual cases, rather than pure extrapolation and unsubstantiated generalizations from Tula or the Aztecs to other groups, shows factual evidence which contradicts Wittfogel's original analysis. For example, chinampas, which Kirchhoff gives as a specific Mesoamerican cultural trait (Kirchhoff 1952), were restricted to small areas and appear to be a late development. In contrast, dams of complex engineering skill existed earlier in the Tehuacan Valley (cf. Woodbury and Neely, this volume). Some ethnic groups appear to have complex social structures without irrigation while other irrigated areas present a picture of small emerging underdeveloped village-states.

Sanders and Price (1968), following Wittfogel, tend to present archaeological overviews of the region, but inadequately present the relevant ethnography of Conquest time, and contemporary variants are either ignored or dismissed. For example, it is assumed that "the overall political structure of Tenochtitlan seems to have been similar to that of smaller city-states . . ." (*op. cit.*, 159). This contradicts their claim that they are not implying a derivative character to the other regional cultures of Mesoamerica (*op. cit.*, 189). Instead of relying on comparative data within the macro-area, they rely primarily upon elaborate arguments based on data from outside Mesoamerica, a procedure which is reliable only when rigorous, controlled cross-cultural comparisons are established. These they have not always done. Sanders and Price (*op. cit.*) criticize Coe for projecting Aztec characteristics into the past of other Mesoamerican peoples while they project Aztec characteristics into the historical present of other Mesoamerican people. That is, they attribute the general characteristics of the Aztecs to all the populations of the central highlands, or at least to those of what they call the symbiotic region, even though it is ecologically diverse and structurally heterogeneous. This generalization is unreliable because, as we have partially documented, the Aztecs were on many counts different, especially if one distinguishes an ethnic group from its social institutions and the general cultural area in which it participates. Also we know very little of this particular topic from ethnohistorical analysis about other groups, because most everybody has been using the few published sources dealing mostly with the Valley of Mexico and happily projecting from it into the Mesoamerican universe. Sanders has promised to analyze the enormous bulk of ethnohistorical manuscripts from the Teotihuacan area which are relevant for political history, but in his previous unpublished reports he restricts his evidence to the mythological proto-historical data already published. At this stage, for example, we do not know why some communities in the area of San Juan Teotihuacan had primacy rights over some water springs. This criticism is not intended to dismiss either Wittfogel's or Sanders and Price's astute and stimulating contributions. We are primarily concerned with documentation.

Present evidence suggests that the situations outside the lake area of the Valley of Mexico resemble more the "sub-marginal hydroagricultural" (fragmented) pattern of irrigation of the Japanese rather than the "hydraulic" (coordinated) pattern (Wittfogel 1957*b*: 197). As in Japan, the irrigation systems of most of highland Mesoamerica were managed by local rather than "national" or macro-state leaders. Furthermore, generalizing from the Cuicatec or Tehuacan town-states, Aztec state control, excepting tribute extraction, was weakly developed. Taking still another tack, and looking at the local state systems as culturally derivative outgrowths of the key areas (an assumption which has not been demonstrated), one could reclassify other small state systems not based on irrigation as emerging marginal hydraulic societies. But this would include the whole Mixtec highlands! Many of these would not have yet reached the level of development and integration or absorption characteristic of the model of a loose hydraulic society or of "oriental despotism." We have shown that among the Cuicatec irrigation *was* a significant variable in the organization and distribution of political power, in warfare, and in settlement pattern. However, we do not see the autochthonous ruling elites as purely bureaucratic functionaries of a macro-state, nor as despotic, or even exceptionally autocratic. Nor can we support the idea that irrigation was the only or major source from which their authority emerged.

In areas in other provincial regions where irrigation was present, for instance Colima, probably the local elites were actively involved in water and land management, and their monopoly of these activities would have certainly enhanced their authority, as it did among the Cuicatec. But other regions apparently without irrigation, for instance some states in the highland Mixtec, also had the same type of political system at Conquest time. Obviously, other scarce resources such as alluvial bottomlands in non-irrigated intermontain valleys, minerals which require cooperation for their regular profitable extraction, manufactures or trade control, etc., could have served as well as water as bases for monopolizing political power. Moreover, and I think we have more than illustrated the point, given the conditions of water scarcity characteristic of most of highland Mesoamerica outside the lake area, irrigation was a factor in fostering social schismogenesis, but not necessarily centralization, after a certain threshold of growth. The size of the irrigation networks did not tend to increase the strength of the elite or political growth at the local levels above the range of town-states. If taken at all seriously, Wittfogel's ideas need both modification and expansion in the light of new evidence.

The problem of discussing this hypothesis in more specific terms derives from the extreme paucity of published ethnohistorical analyses. Sauer's (1948) data on the Colima region are extremely valuable, but his approach is geographic rather than sociological and so an analysis of native political structure to match the ecological analysis is missing. In order to compare Colima with the Cuicatec materials, an analysis of Sauer's original sources is required; that is, it would be necessary to apply to the Colima region the same method utilized for the reconstruction of the Cuicatec. Ecological similarities are abundant. The location of settlements adjacent to water sources, the areas of high concentration of population, the presence of high culture, etc., all exist where high production, orchards, or irrigation are mentioned. But little is known of the local political arrangements except that the area was fragmented into small states occupying riverine valleys or alluvial bottomlands, at least in the lowland sector. In the highlands, however, urban centers seem to be associated with mining and commerce.

Gibson's (1952) superb work on the Tlaxcalans discusses politics but not irrigation. Data on the Totonac are purely inferential (Palerm 1955) in spite of Kelly and Palerm's (1952) interest in the topic. In the ethnohistorical sections which are pioneer for their quality, other problems are focused upon: language distributions, migrations, relation to the Aztecs, etc. Palerm's (1955) later analysis of the Totonac irrigation, based on data extrapolated from contemporary techniques and distributions, is suggestive but undocumented and its relevance to pre-Hispanic arrangements is dubious.

Although Dahlgren's data, as well as Caso's and recently Spores's, are available for the Mixtec, especially the highlands, existing monographs are not usable for comparative purposes either because they are non-historical (e.g., Ravicz 1965) or because they are general syntheses (e.g., Dahlgren de Jordán 1954; Spores 1967). Spores makes general statements about the whole language group but the degree of internal variation is, for the most part, disregarded in the analysis. The Mixtec relaciones ca. 1580 show a high degree of social and cultural variation but modern analyses lump these variants into a single ethnographic picture. If there were clear variations between the highland and canyon social organization in the Cuicatec area, it is to be expected that intra-area variation was also the case among Mixtecs, and among other language groups as well. Moreover, Dahlgren's studies of ecology and agricultural techniques and her study of the political organization or dynasties are treated separately, so that the relevance of one topic to the other is not explicit and cannot be elicited from the materials as presented in published form. Irrigation is seldom mentioned. It is obvious that some semi-urbanized centers, such as Juxtlahuaca, depended upon it then as they do today. The highland Mixtec was without doubt dessicated by overgrazing and climatic changes, in part due to deforestation, and it is possible that irrigation was practiced in many more areas than the present evidence indicates. Cook (1949, 1958) and Simpson (1952, N. B. sections 18 and 20) have postulated as well as partially demonstrated that this must have been the case. Obviously the resources and population densities of the area were greatly reduced after Spanish entry; evidence on irrigation from historical research is very scanty and from archaeology not yet secured. Extensive terracing adjacent to intermontain river valleys is commonly found near important pre-Hispanic political centers such as Yanhuitlan. However, the chroniclers failed to discuss irrigation and if it was present it is quite obscure why they ignored it.

The truth of these hypotheses is not directly significant since non-irrigated centers could have adopted, by cultural borrowing and partial social absorption, the political arrangements of adjacent, better developed civilization centers. At this point, it is only by fashion or personal preference rather than by rigorous interpretation that a particular hypothesis can be defended for highland Mesoamerica as a whole. More problematic is the wider discussion which incorporates the lowland Maya in a single evolutionary scheme.

The evaluation of irrigation as a significant variable within a general evolutionary scheme, however, is a separate and different issue. The need for revision of Wittfogel's complete set of hypotheses as presented in his major works need not imply that irrigation is being dismissed as a significant factor in the evolution of Mesoamerica as a whole. Little can be added concerning this more general problem by looking at Cuicatec, or similar, data because of its lack of time depth and archaeological documentation. We are not engaging in a game of tug-of-war in hypothesis building. We were in this context simply working backwards from the most recent developments in search of possible relevant evidence. However, data is accumulating from recent archaeological investigations elsewhere, and it may be relevant here to look summarily to this data for tentative answers.

Until recently, little was known of the historical depth of irrigation in Mesoamerica. Some recent studies, many of them still in the process of being completed, have added increased time depth to the appearance of this highly successful agricultural technique. Sanders's (1965) work in Teotihuacan, although inconclusive at present, seems to point to the presence of irrigation at least from the Classic Period, over the span of time in which Teotihuacan developed as the great urban center of mythological and archaeological fame. Unfortunately, what he treats as an hypothesis in early descriptive, documented, unpublished reports becomes a certainty in his later presentation (Sanders and Price 1968). MacNeish's (1964*b*) work and that of his collaborators in the Tehuacan Valley is an example of all that can be desired in documentation. They uncovered several large systems of irrigation including "fossil canals" and one large dam dating to the later stages of the Formative, starting in the Santa Maria phase, ca. 900-200 B.C., and in addition innumerable local irrigation niches (Byers, Ed., 1967: 11, 81-87, 223-224, 228 passim; MacNeish, Nelken-Terner, and Johnson 1967: 12; Woodbury and Neely, this volume). The complexity of the technology and the expanding size of the dam site over a long period indicates that this was not an experimental development but an elaboration and expansion of earlier techniques of water control already in existence, at least as early as the Middle Formative. Botanical remains and other multidisciplinary data in their area check with the early dates for the beginning of this technique. Flannery and his co-workers' 1967 research in the valley of Oaxaca, moreover, recently discovered well and bucket systems of irrigation for early prehistoric periods in that valley beginning ca. 900-600 B.C., in the Guadalupe phase. These data leave no doubt as to the interrelation of irrigation, a growing population, trade, and the emergence of such massive architectural centers as Monte Alban with their political implications.

But to what extent can irrigation be seen as a sufficient cause for the development of civilization, for large centralized urban states, or for the rise of autocratic despotic power elites? Ethnohistorical evidence from the Cuicatec, the Teotitlan del Camino area, and the Tehuacan Valley (Woodbury and Neely, this volume, and unpublished data) suggests that the local provincial elites of these areas were, from early times, intensively involved in water management. The case of Chilacatla, studied by a local amateur Mexican historian (chap. 4) and based on extensive Colonial documents is a superb example of this situation. In the valley of Oaxaca, however, a high water table and the probable ability of the local farmer to irrigate without outside control, suggest that water, at least in the valley floor, was not in the same sense a valuable political commodity. The situation on the mountain slopes, however, and the spurs above the valley probably resembled that of the Cuicatec. One could hypothesize that administrative bureaucracies may have been involved in the redistribution of agricultural fields located in the favored alluvial sector of the Atoyac river basin. This, however, is purely speculative. But we have moved far from earlier statements, such as Wolf and Palerm's (1955), where our only evidence of irrigation networks came from the lake area and from periods when the centralized state system was already developed.

The problem in thinking of this issue has been that supporters of the hydraulic society have over-emphasized irrigation and its ecological complex as a *sufficient cause* for the later complex social situations found by the Spaniards in Mexico. To think in terms of sufficient causes in this context is, we think, naive. No single variable can produce complex socio-cultural developments on its own impetus. Anthropologists know by now that to blanket-name or type societies on the basis of unique factors provides poor models for analysis or comparative work. Irrigation has been proposed as the major factor in increased surpluses, new plant domestications, and population growth. It has also been pointed out as the fundamental variable which allowed for the concentration of population in large, permanent, urbanized settlements. Now it is also suggested that irrigation be considered the sufficient and fundamental cause for the growth of civilization, political integration, and centralization. As we have shown, outside the small lake area of the Valley of Mexico, the ecological conditions necessary for the building of elaborate hydraulic societies were not always present, due primarily to water shortage. Obviously, however, it was no accident that the major urban centers in the highlands, such as those in the plateau valleys of Mexico and Teotihuacan, Oaxaca and Puebla, developed where the possibility of more intensive controls of irrigated agriculture was feasible. These are indeed the "key areas" in terms of the development of nuclei of emerging civilization (Palerm and Wolf 1957), but the irrigation networks are relatively small compared with examples from other civilizations such as China or Mesopotamia. Thus, irrigation did not necessarily play the same role here.

To reject irrigation as a highly significant variable, however, is to be equally prejudiced. In a socio-cultural system, change in one variable, for example, the change to a more successful agricultural technique, is concatenated with readjustments and changes in other variables in the system.

If we take this anthropological truism into account we can propose that irrigation may have played a major role as a *necessary* rather than a *sufficient* cause for the emergence of civilization and large city-states with imperial proclivities in the Mesoamerican highlands. Without it, the arid and semi-arid regions of the central plateau could have produced neither the surplus necessary for the maintenance of a permanent large class of non-agriculturalists, nor the labor input required to build monumental cities with corvée labor over short time spans or to maintain conquering armies. Irrigation can be seen as triggering other complex developments. After the introduction of this complex, even in small scale, the human ecology and the social organization of the highlands obviously suffered great transformations in the emergence of new forms of social structure and the creation of new social needs. An incipient class of bureaucrats, military men, and tradesmen may have emerged at the local levels under the conditions of wealth provided by irrigation. At this point we may be dealing purely with advanced, complex village or tribal chiefdom organizations. It is not necessary that irrigation trigger anything more than a series of small readjustments. In itself it does not produce despotic centralized states, predatory conquest, and so forth, but it could have the effect of the stone that starts an avalanche. Offshoot migration of an expanding population, and the exchange of craft goods for initially local trade outside a redistributive net, or purely for ritual purposes, can be extended into a complex market system by peaceful frontier incorporation into the regional networks. A small military group created for defense purposes can refocus its function from protection to subordination of local populations. A priesthood geared to ideological needs of a peasant group may elaborate its dogma and ritual far beyond the original needs of the system, especially if it manages to control esoteric knowledge which appears culturally relevant to the masses, such as weather prediction, horoscopes, etc. Men and goods do not move alone. Women can be traded as well as objects. Ideas can be carried without conscious proselytizing by the men who believe in them. In their wake, culture, including particular forms of political ideology, can diffuse by stimulus contact into regions where it could not have developed given previous evolutionary stages. One need only consider the recent spread of the industrial complex and western ideology into regions such as West Africa. No part of this steady process requires the elaborate evolutionary scheme which continues to maintain irrigation as its significant *Deus ex machina.* Nor does it require the emergence of autocratic or despotic political systems (although it is perfectly possible or logical that this may occur). Large areas can be integrated through peaceful economic exchange, cultural incorporation, and the "internationalization" of regional political elites sharing common class interests. From then on, other variables far removed from ecological or technological ones may dominate the picture or cause further developments. In fact, it is possible, as Durkheim (1883) suggested long ago, that the higher the level of social development in the evolutionary scale, the more complex the division of labor, the lesser the importance of ecological or technological factors in determining specific historical types.

All of the above discussion is in line with the recently acquired evidence and the synthetic interpretative fashions of most present-day Mesoamericanists, but must be understood as highly problematic, and mostly hypothetical. In every field of inquiry there comes a time when the researchers have to turn from an embarrassment of riches in terms of hypothesis to the poverty of rigorous data searching. It is very clear that the time is here and now in Mesoamerican archaeology and cultural history. The evidence is there for those who desire to uncover it.

PUBLISHED REFERENCES

Acosta, 1965.
Adams, 1956, 1960, 1966.
Adan, 1922.
Alvarado, 1593.
Anales de Cuauhtitlan . . . (Codex Chimalpopoca), 1945-47.
Anales de Tlatelolco . . . (Berlin and Barlow, Eds., 1948).
Angulo y Mayo and Freeland, 1933-34.
Arana Osnaya, 1959, 1960.
Arana Osnaya and Swadesh, 1965.
Armillas, 1948, 1949, 1961, 1964.
Armillas, Palerm, and Wolf, 1956.
Arzobispo de Mexico, 1560 (Paso y Troncoso, Ed., 1939-42).
Attolini, 1949, 1950.
Baez, 1909.
Bandelier, 1878.
Barlow, 1943, 1944, 1949, 1962.
Basauri, 1928, 1940.
Bateson, 1958.
Beardsley, Hall, and Ward, 1959.
Belmar, 1901, 1902, 1905.
Berlin, 1947.
Berlin and Barlow, 1948.
Berlin and Kirchhoff, 1947.
Bernal, 1962, 1965*a*.
Bevan, 1938.
Binford, 1968.
Boletín del AGN, 1940.
Borah and Cook, 1958.
Bradomin, 1955.
Bravo, 1960.
Buiza, 1551 (Paso y Troncoso, Ed., 1939-42).
Burgoa, 1670 and 1674.
Burland and Kutscher, 1955.
Byers, 1967 (Ed.).
Calnek, 1960, 1963, 1969*a*, 1969*b*.
Carrasco, 1950, 1961.
Caso, 1953, 1958, 1959, 1960*a*, 1960*b*, 1961, 1963, 1964 (Ed.), 1965*a*, 1965*b*, 1966.
Caso and Bernal, 1965.
Castañeda and Dabbs, 1939.
Cerda Silva, 1942.
Cervantez de Salazar, 1914.
Chamberlain, 1939.
Chavero, 1892.
Chavez Orozco, 1943, 1951-53.
Clark, 1938.
Cline, 1956, 1957, 1961 (Ed.), 1963, 1966.
Codex Baranda (or Alvarado?).
Codex Fernandez Leal (Peñafiel, Ed., 1895).
Codex Mendocino (Codex Mendoza) (Clark, Ed., 1938).
Codex Porfirio Diaz (Chavero, 1892).
Comisión del Papaloapan, 1956*a*.
Cook, 1949, 1958.
Cornyn, 1926.
Dahlgren de Jordán, 1954, 1962.
Dalton, 1965.
Dark, 1957.
Davis, 1952-58, 1954, 1963.
Davis and Walker, 1955.
Dibble, 1940, 1951 (Ed.).
Durkheim, 1883.
Epistolario de la Nueva España (*ENE*) (Paso y Troncoso, Ed., 1939-42).
Espinosa, 1910.
Esteva, 1913.
Evans-Pritchard, 1940.
Eyre, 1955.
Fernea, 1963.
Flannery *et al.*, 1967.
Fortes, 1953.
Galvan Rivera, 1870.
Ganshof, 1961.
Garcia Granados, 1935, 1953.
Garcia Pimentel, 1904.
Gay, 1881.
Geertz, 1959, 1963.
Gibson, 1948, 1952, 1964.
Gil Huerta and Neely, 1967.
Glass, 1964.
Glick, 1970.
Gray, 1963.
Herrera, 1726.
Holland, 1959.
Hunt, E., 1969, n.d.
Hunt, E., and R. Hunt, 1968.
Hunt, E., and Nash, 1967.
Hunt, R., 1965, 1968, 1971.
Hunt, R., and E. Hunt, 1967.
Hunt, R., E. Hunt, and Weitlaner, 1968.
Icaza, 1925.
Ixtlilxochitl, 1892.
Jiménez Moreno, 1953-56, 1962.
Jiménez Moreno and Higuera, 1940.
Kelly and Palerm, 1952.
Kirchhoff, 1940, 1947, 1952, 1954-55, 1955.
Klein, 1966.

Leach, 1954, 1961.
Lehmann, 1905.
Lemoine Villicana, 1954.
Lesur, 1968.
Lewis, 1967.
Lienzo Antonio de León (Caso, 1961).
Linton, 1962.
Longacre, 1957, 1967.
Lopez, 16th C.
MacNeish, 1964*b*.
MacNeish, Nelken-Terner, and Johnson, 1967.
Martinez Gracida, 1883.
Martinez Ríos, 1961.
Memorias del Estado de Oaxaca, 1874-75.
Mendizabal, 1929.
Miles, 1957.
Millon, 1954, 1955, 1957, 1962.
Millon, Hall, and Diaz, 1962.
Miranda, Swadesh, and Weitlaner, 1960.
Monzón, 1949.
Motolinía, 1903, 1941.
Murdock, 1960.
Needham and Davis, 1946.
Nicholson, 1966.
O'Gorman, 1937, 1945.
Olson, J. C., 1958.
Olson, R., 1933.
Orozco y Berra, 1864.
Paddock, 1962, 1966 (Ed.).
Palerm, 1954, 1955.
Palerm and Wolf, 1957, 1961 (Eds.).
Papeles de la Nueva España (*PNE*) (Paso y Troncoso, Ed., 1905).
Pareyon, 1960.
Paso y Troncoso, 1905, 1912, 1939-42.
Peñafiel, 1885, 1890 (Ed.), 1895, 1897.
Perez, 1888.
Piña Chan, 1960.
Poleman, 1964.
Ponce, 1873.
Prebish, 1963.
Publicaciones del AGN, 1952.
Ravicz, 1965.
Redfield, 1928.
Reina, 1967.
Relación de Atlatlauca y Malinaltepec (Mezquita, 1580).
Relación de Coxcatlan (Castañeda Leon, 1580).
Relación de Cuicatlan (Gallego, 1580).
Relación de Cuilapa (Barlow, Ed., 1962).
Relación de Guautla, 1580 (Bernal, 1962).
Relación de Ixtepexi (Ximenes Ortiz, 1579).
Relación de Juan Bautista de Pomar (Garibay K., 1582).
Relación de los Obispados . . . (R. de O.) (Garcia Pimentel, Ed., 1904).
Relación de Papaloticpac y su Partido (Navarrete, 1579).
Relación de los Pueblos de Tecuicuilco, . . . , 1928.
Relación de Teotitlan del Camino (Castañeda, 1581).
Relación de Usila (Quijada, 1579).
Reyes, 1593.
Ricard, 1933.
Rickards, 1926.
Robertson, 1958, 1959, 1964.
Roys, 1939, 1943.
Sahlins, 1958.
Sanders, 1956, 1960-63, 1963, 1965.
Sanders and Price, 1968.
Sauer, 1948.
Schaedel, 1968.
Scholes, 1936.
Selden Roll (Burland and Kutscher, Eds., 1955).
Seler, 1906.
Seler-Sachs, 1912.
Service, 1962.
Simpson, 1937, 1952.
Sjoberg, 1952.
Spores, 1964, 1965, 1967.
Starr, 1899, 1900, 1902, 1908.
Steward, 1955 (Ed.).
Suma de Visitas . . . (Paso y Troncoso, Ed., 1905).
Swartz, Turner, and Tuden, 1966.
Taracena, 1941.
Tinoco, 1699.
Torquemada, 1723.
Vansina, 1965, 1967.
Velasco, 1891.
Villaseñor y Sanches, 1748.
Weber, 1947.
Weitlaner, 1961, 1969.
Weitlaner and Castro G., 1954.
Weitlaner and Holland, 1960.
Willey, 1956 (Ed.).
Willey, Ekholm, and Millon, 1964.
Wittfogel, 1955, 1957*b*.
Wolf, 1959, 1966.
Wolf and Palerm, 1955.
Zarate, 1544 (Paso y Troncoso, Ed., 1939-42).
Zavala and Castelo, 1939.

UNPUBLISHED REFERENCES

Aragon Coronado, Felipe

1954 Girones de Nuestra Patria: Santos Reyes Papalo, Oaxaca, Mexico. Unpublished Normal School thesis. (Copies available at the Instituto Nacional de Antropología, Weitlaner's files. Departamento de Investigaciones Antropológicas.)

Archivo General de la Nación (ordered by volume and *expediente*)

A. Ramo de Indios

Tonaltepec

1575 Tasación que se hizo a Juana Salazar por ser mujer legitima del cacique de Tonaltepec, Pedro de Salazar, y solicitando el cacicazgo de su esposo. Vol. 1, Exp. 30 F. 12.

Papalotiepa

1575 Tasación de salarios al gobernador, alcaldes, regidores y otros oficiales que de las sobras de tributos se les señalo en el pueblo de Papalotiepa. Vol. 1, Exp. 47 F. 18.

1578 Tasación que solicita Juan Gaitan por ser cacique y Gobernador de Papalotiepa. Vol. 1, Exp. 162 F. 59 vta.

Cuicatlan

1583 Tasación de salarios que se asigno de los bienes de comunidad y sobras de tributos al gobernador, regidores y alcaldes del pueblo de Cuicatlan. Vol. 1, Exp. 279 F. 122 vta.

1568 Solicitud que hacen los vecinos de C. para no pagar tributos durante seis años y poder reedificar su iglesia que se les destruyo en un incendio. Vol. 1, Exp. 288 F. 127-8 vta.

Teutila

1582 Para que se la devuelvan a Juan Raudor veinticuatro cargas de cacao que el Alcalde Mayor de T. le quito. Vol. 2, Exp. 72 F. 17.

1582 Para que el alcalde Mayor de T. cumpla el mandamiento que en razón del cacicazgo del pueblo de Papaloticpac esta dado a Marcos de Aguila. Vol. 2, Exp. 74 F. 18.

Papaloticpac

1582 Al Corregidor de P. para que informe del cacicazgo de Doña Maria Hernandez natural del dicho pueblo y si es de concedercele por lo que solicita. Vol. 2, Exp. 301 F. 74.

Teutila

1583 Ordenando que se guarde y sea compelido por el canonigo Juan de la Cruz Cerezeda lo que esta dispuesto por su Majestad para elegir beneficiado en el pueblo de Teutila. Vol. 2, Exp. 442 F. 106.

Papaloticpac

1583 Para que no se le impida a Melchor Juarez indio de P . . . usar el oficio de sastre y no se le cobren tributos en otros pueblos. Vol. 2, Exp. 512 F. 119.

Tututepetongo

1583 Al Corregidor de Papaloticpac para que no consienta que los naturales de dicho pueblo den cada uno quince pesos para cera y aceite. Vol. 2, Exp. 592 F. 138.

Tepeucila

1583 Su Señoría ordena que se guarde el concierto hecho entre Don Juan Gaitan y los naturales de la estancia nombrada Guapa (Coapan), de Papaloticpac, sobre terrasgueros. Vol. 2, Exp. 757 F. 172.

Tepeucila

1583 Para que el juez de residencia Don Pedro Velazquez Verdugo, haga volver de Tuetila los objetos y animales de Juan Gaitan, que por Real Audiencia le esta mandado. Vol. 2, Exp. 800 F. 181.

Papaloticpac

1583 Ordenando que se le de una sementera de maiz a Marcos de Aguila, como cacique que es del pueblo de P . . . Vol. 2, Exp. 881 F. 201.

Cuicatlan

1583 Comisión a Fco. de Velazquez Corregidor de C . . . para administrar justicia sin salario en el corregimiento de Quiotepec y Tecomavaca. Vol. 2, Exp. 987 F. 227.

Papaloticpac

1590 Que estando hecho juridicamente y siendo solo en lo tocante a tierras, es probada y confirmaba el concierto entre los principales de dicho pueblo y Don Juan Gaitan cacique del mísmo. Vol. 3, Exp. 80 F. 20 and Exp. 81 F. 20.

Papalo (Tututepetongo)

1590-1 Al Corregidor de P. para que conforme a sus recaudos ampare al cacique de Tututepetongo, informando a su señoría. Vol. 3, Exp. 431.

Papaloticpac

1591 Al Corregidor del pueblo de P. para que citando al comun de naturales averigue si Don Sebastian Lopez hijo de Don Miguel sucedio en el cacicazgo de Don Bartolome y que con parecer

jurado cuenta de todo lo relativo. Vol. 3, Exp. 517 F. 120 vta.

Quiotepec

1591 Su Señoria confirma la tasación que se le dió a don Gabriel Monjaras, cacique y Gobernador de Q. Vol. 3, Exp. 767 F. 180.

Cuicatlan

1591 Al corregidor de C. para que juntamente con el religioso o clerigo que los administra informe de los ornamentos de que la iglesia de C. tiene para proveer lo necesario. Vol. 3, Exp. 789 F. 188 vta.

Quiotepec

1591 Para que la justicia de Q. pagar a Doña Juana de Salazar lo que se le adeuda a su difunto marido, Don Francisco de Monjaras como cacique del dicho pueblo. Vol. 3, Exp. 908 F. 221.

Quiotepec

1591 Para que el corregidor de Q. haga averiguaciones de los capitulos puestos a Juan Martin alguacil Indio y lo envie a su señoría. Vol. 3, Exp. 909 F. 222.

Quiotepec

1591 Al corregidor de Q. para que constando que las casa y tierras son de Doña Juana de Salazar y de sus hijos le ampareis en ellas, sin perjuicio de tercero. Vol. 3, Exp. 910 F. 222.

Papaloticpac

1591 Su Señoría declara por cacique y Senor natural del de P. a Don Sebastian Lopez Indio Principal del mencionado pueblo. Vol. 3, Exp. 950 F. 230.

Tututepetongo

1591 Al Corregidor de Papaloticpac para que haga averiguaciones si las tierras que menciona son de don Miguel de San Francisco, para que constando ser de su propiedad, les ampare en su posesión. Vol. 3, Exp. 966 F. 233.

Teutila

1590 Licencia a don Tomas de los Angeles indio principal de T. para traer espada. Vol. 4, Exp. 525 F. 156 vta.

Papaloticpac

1590 Licencia a Don Alonso Peres de Guzman para que como cacique de P. pueda montar a caballo. Vol. 4, Exp. 560 F. 164.

Tepeucila

1590 Al Corregidor de Papalotiquipaque para que dando los indios la cera necesaria para decir misa y para los demas oficios divinos no sean compelidos a dar para el pueblo de P. Vol. 4, Exp. 955 F. 256.

Quiotepec

1591 Al Corregidor de Q. para que citando el comun de dicho pueblo e interesados averigue si Gabriel de Monjaras es hijo mayor legitimo de don Miguel de Monjaras y todo lo relativo para proveer lo conveniente. Vol. 5, Exp. 917 F. 305.

Cuicatlan

1591 Al Corregidor de Cuicatlan para que lo que se les debe a los oficiales de la Republica, se los haga pagar de los bienes de Comunidad, conforme a la tasación que para el efecto les esta dada. Vol. 5, Exp. 991 F. 325.

Atlatlahuca (Uncertain. May refer to a town in Puebla.)

1592 Se concede licencia a Martin Maldonado cacique de A. para montar a caballo. Vol. 6 (First Part), Exp. 180 F. 46.

Papaloticpac

1592 Al corregidor de dicho pueblo para que sea aprobada la petición de los indios del dicho pueblo. Vol. 6 (First Part), Exp. 260 F. 66.

Cuicatlan

1593 Para que los naturales de dicho pueblo labren y beneficien cada uno una sementera de maiz y otra de frijol de cien y cuatrocientas brazas en cuadra. Vol. 6 (First Part), Exp. 479 F. 128 vta.

Teutila

1593 Al Alcalde Mayor de Teutila para que el beneficiado de dicho pueblo haga un inventario de los ornamentos que hay y que necesitan para su iglesia, a fin de proveer lo mas conveniente. Vol. 6 (First Part), Exp. 539 F. 143.

Teutila

1593 Licencia a Don Damian Perez, indio de Teutila, para montar a caballo. Vol. 6 (First Part), Exp. 540 F. 143 vta.

Papaloticpac

1594 Para que en termino de veinte dias aparezca ante su señoría Don Juan Gaitan, indio principal de dicho pueblo. Vol. 6 (First Part), Exp. 803 F. 215.

Atlatlauca

1597 Se dio el titulo de gobernador para el pueblo de A . . . por un año, a Don Martin Maldonado, indio principal de dicho pueblo. Vol. 6 (First Part), Exp. 1182 F. 325.

Papaloticpac

1591 Al corregidor de dicho pueblo para que habiendo cesado la causa por la que Veronica, india principal de dicho pueblo fue desterrada, y no procediendose todavia en contra de ella, permita que vuelva a su casa. Vol. 6 (Second Part), Exp. 56 F. 14.

Al corregidor de dicho pueblo para que haga averiguación sobre si Juan Gaitan y demás indios de P . . . son revoltosos enviandola a su Señoría para que provea lo mas conveniente. Vol. 6 (Second Part), Exp. 399.

1592 Al corregidor de dicho pueblo para que en

union del clerigo me informe con inventario de los ornamentos que hay en la iglesia y los que le falten. Vol. 6 (Second Part), Exp. 456 F. 101 vta.

1592 Al corregidor de P . . . para que vea si la elección de oficiales de Republica en dicho pueblo se hizo jurídicamente como lo han acostumbrado. Vol. 6 (Second Part), Exp. 660 F. 151 vta.

1592 Al corregidor del pueblo de P . . . a fin de que notifiquen a Juan Gaitan que salga del pueblo. Vol. 6 (Second Part), Exp. 752 F. 178.

Yepaltepec (Papalo estancia)

1595 Manda su señoría que le den catorce indios para su servicio a Juan de Guzman, cacique de Yepaltepec. Vol. 6 (Second Part), Exp. 1052 F. 285 vta.

San Gabriel Po. Tehuacan

1616 Para que el Alcalde Mayor de Tehuacan reciba información al Gobernador y común del pueblo de . . . S.G. sobre si la merced concedida a Juan Moreno fue de las contenidas en el mandamiento de su Excelencia y siendole se le notifique y haga uso de ella. Vol. 7, Exp. 87-8.

Tehuacan

1616 Sobre tasación de la sal. Vol. 7, Exp. 89.

Papalo

1616 Licencia que se concede a Fco. Perez cacique de P. para que libremente pueda montar a caballo, portar espada y daga. Vol. 7, Exp. 113.

Quiotepec

1618(?) Licencia a Juan de Monjaras cacique de Q. para montar a caballo, portar habito de español, espada y daga. Vol. 7, Exp. 121.

Tehuacan

1616 La sal es privilegio del cacique Francisco Moctezuma. Vol. 7, Exp. 129.

Papalo

1616 Para que el corregidor de P. desembarque al Gobernador de dicho pueblo Don Francisco Perez de Guzman las cabras y semillas que tiene embargadas por motivo de haberle puesto capitulos como consta por testimonio. Vol. 7, Exp. 131 F. 64.

Los Cues

1617 Encarga su excelencia al beneficiado de Cuicatlan cumpla con la obligación que tiene respecto a sus feligreses. Vol. 7, Exp. 141.

Papalo

1617 Su Ex. espera a los naturales de P. por tiempo necesario para pagar el tributo y servicio real que deben a su Magestad. Vol. 7, Exp. 182.

Papalo

1618 Se revoca el nombramiento de Gobernador hecho por el Corregidor de P. en Pedro de Monjaras y que el Indio que en las elecciones salio nombrado para el presente año use libremente el cargo de Gobernador. Vol. 7, Exp. 285 F. 140.

Atlatlauca

1618 Licencia al cacique Monjaras. Vol. 7, Exp. 332.
Licencia al cacique Angel Maldonado para usar espada y caballo. Vol. 7. Exp. 333.

Quiotepec

1619 Para que el corregidor de Q. reparta el tiempo de sus visitas por los pueblos de su jurisdicción. Vol. 7, Exp. 346.

Papalo

1619 Al Corregidor de P. a fin de que deje libremente a Fco. de Guzman en dicho pueblo y si en su contra tuviere algunas causas las remita al Tribunal del Juzgado de Indios para que su Señoría provea lo conveniente. Vol. 7, Exp. 348 F. 169.

Tehuacan

1619 Un Pleito de tierras y aguas. Vol. 7, Exp. 352.

Santa Maria Tequisquitla (near Tehuacan)

1620 Un Pleito de tierras y aguas. Vol. 7, Exp. 484.

Teponaxtla

1620 Licencia a gaspar Melchor principal de San Juan T. para montar a caballo. Vol. 10 (Cuaderno Primero), Exp. 42.

Cuicatlan

1631 Se encarga al beneficiado de C. para que no intervenga en las elecciones de oficiales de republica y que las justicia no lo permita. Vol. 10 (Second Part), Exp. 30.

Papalo

1631 Su excelencia declara no haber lugar a la reserva que piden los naturales de P. del servicio personal y manda que no se les obligue a dar mas Indios. Vol. 10 (Second Part), Exp. 78.

San Lorenzo (near Tehuacan)

1631 Sobre derechos de aguas. Vol. 10 (Second Part), Exp. 102.

B. Ramo de Tierras

Tecomavaca

1630 Su Ex. manda que se lleven los autos en razon de lo que pretenden los naturales de T . . . y Cuycatlan para que estes corregimientos se agreguen y formen uno para. . . . Vol. 10 (Cuaderno Primero), Exp. 252.

Tututepetongo

1712 Sobre Don Benito de Mendoza cacique de T. Vol. 288, Exp. 3.

Papalo-Los Reyes

1711-6 Los Naturales del pueblo de Papaloticpac contra los de los Reyes, sobre tierras. Vol. 288, Exp. 3 F. 126.

Cotahuixtla, San Francisco

. . . . Vol. 299.

Teutila

1745-6 Francisco de Aragon y Valencia sobre que se agreguen a la jurisdicción de Teutila los pueblos de Usila, Papantla, Yetla, Tuxtepec, Jacatepec y Usumacin. Vol. 675, Exp. 4 F. 24.

1751-2 Los naturales del pueblo de San Miguel Soyaltepec contra Fndo Carlos de Rivadeneira, dueño de la hacienda San Fco. Estanzuela, sobre propiedadde tierras. Vol. 742, Exp. 4 F. 17.

1754 Los Naturales del pueblo de San Miguel Soyaltepec contra el dueño de la hacienda la Estanzuela, sobre destrucción de sus mojoneras. Vol. 789, Exp. 4 F. 9.

1761 Los Naturales del pueblo de San Juan Bautista Quaxospan o Cuazospan, contra los del barrio de San Miguel Huautla, sobre propiedad de tierras. Cita el pueblo de San Bartolome Ayautla. Vol. 868, Exp. 8 F. 142.

Cotahuixtla-Nacaltepec (Teotitlan del Camino)

1767-1810

Los naturales del pueblo de Santiago Nacaltepec contra los de San Francisco Cotahuixtla, sobre propiedad de tierras. Diligencias de partición del pueblo viejo de Ejutla, entre dichos dos pueblos Incluye dos planos. Vol. 921, Exp. 3 F. 125.

1585-1721-1769

Tambien de Cotahuixtla. Incluye dos mapas. Vol. 923, Exp. 1 F. 228 (see volume above).

Teutila

1783-7 Los naturales del pueblo de San Juan Bautista Tuxtepec sobre construcción de su Iglesia. Un Plano. Vol. 1139, Exp. 3 F. 26.

Guendulain (hacienda near Cuicatlan)

1715 Vols. 1206-1273-1063 (San Jose and San Miguel). (Land fight involving Indians versus Mestizos and Spaniards.)

Tutepetongo

Vol. 1264(?)

Teutila-Chiquihuitlan-Tlalixtac

1803-4 Los naturales del pueblo de San Juan Chiquihuitlan contra los de Chapulapa y Tlalixtac sobre posesión de tierras. Un mapa. Vol. 1351, Exp. 3 F. 3.

Teutila

1800-11 Los herederos de pedro Antonio Guzman, cura del pueblo de Teutila, contra Jose Enriquez, sobre propiedad de una casa (Contains voluminous information on wages, prices of commodities and staples, inheritance rules, arrangements of owners-administrators of Spanish property, absentee landlordism, etc.). Vol. 1395, Exp. 9 F. 123.

Nanacaltepec

1809 Poder otorgado a los naturales del pueblo de Santiago N. a favor del licenciado Juan Nasario Peimbert. Vol. 1404, Exp. 13 F. 2.

Los Obos-Cuicatlan

1770 Teotitlan del Camino, Miguel de Guendulain, dueño del rancho de Obos, contra los naturales del pueblo de Cuicatlan sobre posesión de tierras. Vol. 1715, Exp. 3 F. 14.

C. *Ramo Mercedes*

Tepeucila-Quiotepec

1561 Francisco Monjaras sobre propiedad del cacicazgo. Vol. 5, F. 357 (also marked in red 337).

Cuicatlan

1597 Dos caballerías a Maria Frejo. Vol. 22, F. 97 vta.

1598 Un año de venta al pueblo de C. Vol. 22, F. 209.

Los Santos Reyes

1786 A Juan Gamarte-Venta del Rancho de San Pedro. Vol. 81, F. 227 vta.

D. *Ramo Acordada*

1783 Sobre el sistema de cortes y Tribunal de Nueva España (contains information on the courts of Teotitlan del Camino and Teutila). Vol. 6, Exp. F. 118-161 vta.

ARCHIVO DEL JUZGADO DE CUICATLAN

1878-92 Documentos sobre pleitos de tierras. (Copies in the author's personal files numbered 2, 6, and 10. Originals in bundles in the storage room of the Cuicatlan Court of First Instance, unnumbered, arranged by year.)

ARCHIVO DEL JUZGADO DE SAN ANDRÉS TEOTILALPAN

1950-65 Documentos sobre la separación de la Agencia Municipal de Chorro de Agua. Copies in the author's files.

BONILLA PACHECO, CAYETANA

1963 Concepción Papalo: Estudio del Medio Físico, Geográfico, Económico y Social. Reporte manuscrito. Instituto de Capacitación del Magisterio, Oaxaca. Unpublished Normal School thesis.

CODEX AYAUTLA (also called Lienzo de Quiotepec [*sic*] y Ayautla)

Pictorial manuscript. Geographic, historical, genealogical. Original in private hands. Photocopies exist in the Instituto Nacional de Antropología, Mexico, and the Library of Congress, Washington, D. C. An incomplete analysis, unpublished, by Wilberto J. Moreno, also exists in the Library of Congress. Listed in the John Glass Census of pictorial manuscripts (1964) under No. 265. (Note: the document does not refer to Quiotepec, but to the Mazatec town of Ayautla, north of the Quiotepec, or Santo Domingo, river. The name of the river appearing in the lower center of the manuscript apparently led to the misnomer.)

CODEX OF QUIOTEPEC (also called Codex de Quiotepec y Cuicatlan or Codex Martinez Gracida)

Middle to Late XVI Century. Pictorial manuscript, partially published in Glass, John (1964) in black and white. A photocopy exists in the Library of Congress. Catalogued in Glass, John (1964) under number 266.

Comisión del Papaloapan

1965 Mapas, Estadísticas y Varios Trabajos sin Publicar de la Colección de la Comisión del Papaloapan. Oficinas de la Comisión. Secretaría de Recursos Hidraulicos. Mexico. Also Oficina de Tehuacan, Mexico.

Expediente de la Composición de Tierras del Pueblo de Papaloticpac, Jurisdicción de Cuicatlan, Oax.

1718 Copies in the Instituto de Antropología. Departamento de Investigaciones Históricas. Relaciones de Oaxaca. Colección de Microfilm. Rollo 146. No. 5 Legajo 55. 46 pp. (A paleographed copy also exists there, and in the author's personal files. References in the text are to pages in this copy.)

(IPCCS) Informe sobre el Pleito que Doña Catarina Salome Cacica de Tepeuzila, sus pueblos y tierras, y vecina del pueblo de Papaloticpac tiene contra Domingo Hernandez.

1562 Instituto Nacional de Antropología. Departamento de Investigaciones Históricas. Relaciones de Oaxaca. Colección de Microfilm. Rollo 146. No. 66 Legajo 55.

Instituto de Geografía de la Universidad de Mexico

1960 Clasificación Estadística y Geográfica de los Municipios y Dependencias de Mexico. Catalogo con arreglo de colores, en tarjetas. Departamento de Demografía.

Jimenez Z., Guillermina

1964 Estudio del Medio Físico, Geográfico, Económico y Social de Cuicatlan, Oaxaca. Instituto de Capacitación del Magisterio. Archivo de la Escuela Urbana Federalizada Clave. Cuicatlan, Oaxaca. (A copy exists also in the Comisión del Papaloapan unpublished documents files.)

Map of Santa Maria Ixcatlan

1580 Ixcatlan Sta. Maria Plan Topographique . . . BN 103 Ex-Aubin Collection. Unpublished. A photocopy exists in the Library of Congress, Washington, D. C.

Osorio, Seberiano

1959 Monografía Histórica-Geográfica de las Comunidades de la Cuenca del Papaloapan: Valerio Trujano. Zona Escolar Cuicatlan 25.a. (Manuscript copy in the files of the grammar school of Valerio Trujano, Oaxaca [also in the document files of the Comisión del Papaloapan].)

Relacion y Mapa de Atlatlauca

1580 Descripción de Atlatlauca y Suchiata (*sic* Sochiapan) por el Corregidor Gaspar de Solis. University of Texas Latin American Collection. MSS. No. 398 of Castañeda and Dabbs (1939) census.

Relacion y Mapas de Ixcatlan

1579 Por el corregidor Gonzalo Velasques de Lara. University of Texas Latin American Collection. MSS. No. 955 of Castañeda and Dabbs (1939) census. The Map has been published in an unreadable version by Robertson (1958).

Relaciones Geográficas del Siglo xviii

1777 Relación de Atlatlauca. BNM 2450 1-3 vta. Copy by Paso y Troncoso (manuscript). Museo Nacional. INAH, Mexico.

1778 Relación de Papalo. BNM 2450 ff. 44-5. Copy by Paso y Troncoso (manuscript). Museo Nacional. INAH, Mexico.

1777 Cuicatlan. Relación del Curato de San Juan Bautista Cuicatlan. BNM 2449 ff. 207-10 vta. Copy by Paso y Troncoso (manuscript). Museo Nacional. INAH, Mexico.

Verbitsky, M. Eva

1955 Notas de Campo sobre los Cuicatecos. Typed manuscript. Files of the Departamento de Investigaciones. INAH, Mexico.

Weitlaner, Roberto

1955 Notas de Campo sobre los Cuicatecos. Typed manuscript. Files of the Departamento de Investigaciones. INAH, Mexico.

APPENDIX: CUICATEC CACIQUES' GENEALOGY, 1172-1620

Mythical Founder of Dynasties (Teutli)
Appears in the IPCCS (1562). War leader of Papalo in war with Quiotepec ca. 1172-1198. Ruler over all Cuicatec territories of Papalo, and Tepeucila, and their subject settlements. Founder of Yepaltepec ca. 1172-1198, from colonists removed from Cacalotepec, an estancia of Papalo.

Citlalteutli or Citlaltecutli (Lord of the Star)
Appears in the IPCCS (1562). Lived ca. 1432-1458 or 1458-1484. Because of an epidemic was the only cacique left of the Papalo-Tepeucila dynasty. Married twice, succeeded by two sons, one from each wife. The first wife was Cacica of Quiotepec, Salado and Tecomavaca, and probably Mazatec. The marriage was contracted to solve the old enmity between Quiotepec and Papalo over the Yepaltepec war. The second wife married after the first's death(?). She was a daughter of the Principal Cacique of Teutila, and probably not Cuicatec.

Yztecutli, Ixtecutli or Ditonidona (C: Great Lord)
Yztecotle (Lord Oxidian [Black Lord?])
Appears in the IPCCS (1562) and the *PNE* (IV:90). Ruled immediately before Spanish entry, at the time of the Aztec conquest (ca. 1510). His dominion included the Papalo subjects of Yepaltepec, Coyula, Llano Tiopa, Zapotitlan, and the cabecera. Lived ca. 1484-1510. Was successor in the direct line from Citlaltecutli, who was his father. His mother was Citlaltecutli's second wife.

Xixichutecutli, Don Juan
Appears in the IPCCS (1562). Son of Yztecutli. Ruled at the time of Spanish entry; died ca. 1542. Was the first of his line to be baptized by the Spaniards, at the age of 60. His dominions included the Papalo barrios and estancias of Coyula, Yepaltepec, Zapotitlan, and Llano Tiopa. Was succeeded by his legitimate son Don Martin Toxtecutli.

Don Martin Toxtecutli (Lord Rabbit)
Appears in the IPCCS (1562). Received a first Tesación from the Spanish government (ca. 1542) to rule over the Papalo estancias of Yepaltepec, Llano Tiopa, Coyula and Zapotitlan; married the cacica of the Papalo estancia of Teponapa, named Doña Maria Palomitas; their son succeeded to the cacicazgos of both parents. They ruled ca. 1524-1542. Son of Don Juan Xixichutecutli.

Dona Maria Dyille Ebe Palomitas (Doña Maria Princess [female Lord] Little Doves)
Appears in the IPCCS (1562). Cacica of the Papalo estancia of Teponapa ca. 1523-1542. Married Don Martin Toxtecutli as senior wife. Her son from him succeeded to her cacicazgo.

Don Lorenzo Toxtecutli (Lord Rabbit)
Appears in the IPCCS (1562). Born 1527; died 1558. Son of Don Martin Toxtecutli and Doña Maria Dyille Ebe Palomitas. Succeeded to the cacicazgos of both parents. Received a Cacique Tasación from Juan Medel, Alcalde Mayor of Partido de Teutila (during the viceroyalty of Don Antonio de Mendoza) for the estancias of Papalo received from his parents. Married the daughter and successor of the cacique of Tepeucila, Doña Catarina Salome, to resolve a territorial dispute between the cacicazgos.

Don Diego Ximenez
Appears in the IPCCS (1562). Born ca. 1542. Son of Don Lorenzo Toxtecutli and Catarina Salome, cacica of Tepeucila. Ca. 1562 his cacicazgo rights were being contended by his father's brother and his father's brother's wife, who ruled over Cacalotepec and Tecomaltianguisco. Claimed and was granted rights over the estancia of Papalo named Yepaltepec.

Canchuchu Caminaa (*sic:* Cuicatec words)
Appears in the *PNE* (IV:95) as lord of Tepeucila at the time of Aztec entry. His connection to previous rulers is not known.

Don Miguel Cullancan
Appears in the IPCCS (1562). Apparently successor of Canchuchu Caminaa, but the connection is not known. Ruled ca. 1523-1530. Married a Papalo cacica whose name is not known. Was succeeded by his daughter from this marriage (Doña Catarina Salome), to the cacicazgo of Tepeucila. Was a "close relative" of Martin Toxtecutli.

Doña Catarina Salome
Appears in the IPCCS (1562). Lived ca. 1523-1562. Daughter of Don Miguel Cullancan. Succeeded him to cacicazgo of Tepeucila. Relinquished her rights when she married, temporarily, to Pedro Monjaras. Her son by Don Lorenzo Tochtecutli succeeded to Yepaltepec. She was exiled from Papalo-Yepaltepec after her husband's death for three years through the machinations of Domingo Hernandes of Cacalotepec (her ex-husband's half-brother) and Francisco Salinas, cacique of Papalo's Barrio Mayor (her own half-brother on the mother's side). They returned until 1562, when her son, Diego Ximenez, successor of

Yepaltepec, became old enough to take the cacique post. She had her Tasación and manuscript documents stolen (claimed Don Domingo had ordered it). She took the case to the Spanish authorities and her son won the cacicazgo, with the help of Francisco Salinas (who changed sides), Alonso de Mendoza (cacique of Cuicatlan), and the macehuales and tequitlato of Yepaltepec.

DON JUAN XUCHILTLAPANO, ALIAS EL ROTO (Lord Broken Flower)
Appears in the IPCCS (1562). Cacique at the time of Spanish entry. Ruled over the headtown of Papalo. Kinsman of Don Juan Xixichutecutli (exact connection is not known). Married the widow of Don Miguel Cullancan, from whom he had a son named Don Francisco Salinas.

DON FRANCISCO SALINAS
Appears in the IPCCS (1562) and the *PNE* (IV:183). Born ca. 1532. Son of Don Juan Xuchiltlapano and the widow of Don Miguel Cullancan, whose name is not known, but who was cacica-principal of Papalo. Ca. 1562 was Gobernador of Papalo's Barrio Mayor. Half-brother of Doña Catarina Salome on the mother's side. Exiled her first from Yepaltepec, later changed his mind and supported her case in court. He had been educated at the school in Tlatelolco for Indian nobility, and was advisor on the writing of the Relación de Cuicatlan (*PNE*, IV [1580]:183).

DON PEDRO DE MONJARAS
Appears in the IPCCS (1562). (A homonym appears in AGN, Ramo de Indios: Vol. 7, Exp. 285[1618]). Kinsman of the cacica of Tepeucila Doña Catarina Salome (exact connection is not known). Was left in charge of the cacicazgo of Tepeucila when Doña Catarina moved to reside in Papalo after her marriage.

DON MARTIN CHIMALTECUTLI (Lord Shield)
Appears in the IPCCS (1562). Cacique of the estancia barrio Huiztepec, of Papalo, of the generation of Don Martin Toxtecutli. Kinship connections with other Papalo lines is not known. His son Don Miguel Hernandez succeeded him. Ruled ca. the time of Spanish entry.

DON MIGUEL HERNANDEZ
Appears in the IPCCS (1562). Cacique of Huiztepec, barrio of Papalo ca. 1562. Successor and son of Don Martin Chimaltecutli. Supported Don Diego Ximenez in the court case. Was educated at the Tlatelolco school for Indian nobility.

NOTASINGUEY (*sic*)
Appears in the IPCCS (1562). Lord of Quiotepec, Tecomavaca, and the Papalo estancias of Tecomaltianguisco and Cacalotepec. Successor in the direct line from Citlaltecutli, probably his first son from his first wife. Succeeded his father to the Papalo estancias, his mother to the Mazatec ones. Ruled ca. 1458-1484.

TICO OR COATECOTLE OR CUHUANTECUHTLI (Lord Snake *Naiye*)
Appears in the IPCCS (1562), *PNE* (IV:186), and Codex of Quiotepec. Successor of Notasinguey (*sic*) to the cacicazgo of Quiotepec. Ruled ca. 1485-1511. Was married to a woman with the title of xnaghanihina (*sic*).

TECOHTOZTLI OR TECUHTOCHTLI (Lord Rabbit) Don Francisco Cortez
Appears in the IPCCS (1562), L. Guevara Papers, and Codex of Quiotepec. Baptized by Cortez. Successor of Coatecotle. Father of Don Pedro Cuetlaxtecutli and Don Francisco de Monjaras (?). Ruled ca. 1511-1523. Succeeded to part of his cacicazgo by his son Cuetlaxtecutli. Was husband (?) (or son?) of a woman named Cihuapili Omemiquiztli (Female Lord 2 death). Given the arrangement of figures in the Codex Quiotepec (behind each other rather than the usual face-to-face) it seems probable to this reader that Omemiquiztli was daughter of Cuhuantecutli, and mother of Tecohtoztli. The text, however, is incomplete, and the IPCCS gives Tecuhtochtli as son, not grandson. Fought war with Cuicatlan.

CUETLAXTECUTLI (Lord Leather)
Appears in the IPCCS (1562). Son of Tecohtoztli. Ruled Quiotepec and Cacalotepec after his father, ca. the time of Spanish entry. Died in 1550. Supported Don Martin Toxtecutli in the ceremony of acceptance of the cacicazgo Tasación for Yepaltepec. His family line changed their name to Monjaras, when Cortez baptized one of them (his brother or son?), named Don Francisco Monjaras. Was succeeded by his daughter, Doña Maria Cuetlaxtecutli, in the settlements of Quiotepec, Tecomavaca, Cacalotepec, and Tecomaltianguisco.

DOÑA MARIA CUETLAXTECUTLI (Female Lord Leather)
Appears in the IPCCS (1562). Daughter and successor of Cuetlaxtecutli. Married Don Domingo Hernandez in 1537. Ruled until ca. 1562.

DON DOMINGO HERNANDEZ
Appears in the IPCCS (1562). Son of junior wife (name unknown) of Don Martin Toxtecutli. Did not succeed his father, for being only "branch of the nobility" (i.e., not a legitimate heir). Was considered principal, and married the cacica of Quiotepec and Cacalotepec named Maria Cuetlaxtecutli. Shared with her the cacicazgo honors. After the death of Don Lorenzo Toxtecutli, forced his widow into exile and took over the management of the Papalo estancia of Yepaltepec. In 1562 was brought to trial, imprisoned, and lost the rights to Yepaltepec which were returned to Lorenzo Toxtecutli's son, Don Diego Ximenez. Attempted, unsuccessfully, to bribe the commoners of the nearby estancias

of Papalo, the governor of Tecpa-Papalo, and others to support his claims, but the principales witnessed against him.

Tiñaña (c) or Tecuantecotle (n) (Lord Fiendish Cannibal, Lord Tiger or Wild Beast; the *PNE* translates it as "Capitan Lion")
Appears in the *PNE* (IV:185). Cacique of Cuicatlan at the time of the Aztec conquest by Moctezuma II, ca. 1510. Succeeded by Chicomecoatl, probably his son (?). His ancestors are not known.

Chicomecotal (Seven Snake; goddess of same name)
Appears in the *PNE* (IV:186). Successor of Tiñaña or Tecuantecotle. Exact kinship connection between the two is not known. Was ruling ca. the time of the Spanish Conquest, over Cuicatlan.

Don Alonso de Mendoza
Appears in the IPCCS (1562). Cacique of Cuicatlan ca. 1562. Supported Doña Catarina Salome and Diego Ximenez in the court case against Don Domingo Hernandez. He or one of his descendants married a descendant of Tecuhtoztli, by the name of Monjaras, probably one of Francisco Monjaras' daughters. Don Benjamin de Guevara, Jefe Politico of Cuicatlan during the Porfirian Regime, and owner of the Fernandez Leal Codex, claimed descent directly from him. It is also claimed (via Elfego Adan [1922]) that Itecotli ([*sic*] Yztecutli?) had been the same as the cacique of Quiotepec baptized Francisco Monjaras y Cortez, married to Doña Catalina de Guzman (*sic*), Hernan Cortez being the godfather. A woman of this Monjaras family (also descendant of Tecohtoxtli [?] married a Mendoza, cacique of Cuicatlan "who was Mixtec" (*sic*). Both contradictory bits of information come from Guevara, via Adan (1922) and Peñafiel (1895). Adan, in all probability, merged two separate pieces of information (see below Francisco de Monjaras). Guevara owned (besides the Fernandez Codex) a lengthy manuscript on the cacicazgos of Quiotepec and Cuicatlan, which has been inherited by his daughter Guadalupe Guevara, but "is not available" for consultation. Probably all these bits of information come from poor readings of this XVI century manuscript. Part of the information appears in the Codice Quiotepec. Both the Codice and the beginning of the Guevara document (the first page of which we read) mentioned the baptism of Tecutochtli in 1527, by Cortez.

Juan Gaitan
Appears in the *PNE* (IV:183) and the AGN, Ramos de Indios y Tierras. (1580-1594). Was tried by the Spaniards (1594) because (?) he attempted a revolt, with Indian support, in 1592, date after which he was exiled. Apparently was cacique of the descent line of the estancia of Coapam, because in 1590 he was in charge of making their land settlements with the collaboration of the estancia principales, and Spanish approval. Was one of the Indian advisors who helped write the Relación de Cuicatlan (*PNE*, IV), during 1580, when he was Alcalde. Received a cacique's tasación.

Doña Maria Hernandez
Appears in the AGN, Ramo de Indios (1582). Her cacicazgo rights were being questioned. Descendant of Don Domingo Hernandez or Don Miguel Hernandez, of Papalo (?).

Marcos de Aguila
Appears in the ACN, Ramo de Indios (1583). Received services in milpa work, for being cacique of part of Papalo.

Don Bartolome
Appears in the AGN, Ramo de Indios (1591). Ruled part of Papalo before 1591. Was succeeded by Sebastian Lopez, who was not his son, but child of a man named Don Miguel.

Don Sebastian Lopez
Appears in the AGN, Ramo de Indios (1591). Cacique of part of Papalo, who received rights in 1591, succeeding Don Bartolome.

Don Juan de Guzman
Appears in the AGN, Ramo de Indios (1595). Cacique of Yepaltepec-Papalo. Received fourteen Indians for service. A kinsman (?) named Alonso Perez de Guzman was granted rights to mount a horse in 1590. Alonso's son succeeded Don Juan. It is possible that Don Juan and Don Alonso were first cousins (Fa Si Son-Mo Br So), and of the family of Doña Catalina de Guzman y Cortes.

Don Martin de Guzman
Appears in the IPCCS (1562). Cacique-Gobernador of Tutepetongo, ca. 1562. Declared in Catarina Salome-Domingo Hernandez court case. Probably a relative of Doña Catalina de Guzman.

Don Miguel de San Francisco
Appears in the Relación de Cuicatlan (1580) and the AGN, Ramo de Tierras (1591). Claimed private ownership of some lands in Tutepetongo. Was governor of Tutepetongo in 1580.

Francisco Perez de Guzman
Appears in the AGN, Ramo de Indios (1619). Jailed by the Spanish Corregidor. Principal of Papalo. Son of Don Alonso Perez de Guzman (AGN, 1590)(?), became cacique of Yepaltepec-Papalo after Don Juan de Guzman, a kinsman of his father. Probably succeeded his father's first cousin. His father appears in the AGN (1590).

Francisco de Monjaras (*Naichhachinga [sic]*)
Appears in the AGN, Ramo Mercedes (1561), and the Codice of Quiotepec and Cuicatlan, about his "ownership"

of the cacicazgo. Probably was contending Doña Maria Cuetlaxtecutli (his brother's daughter) as successor of the settlement of Quiotepec. Kinsman (?) of Don Pedro Monjaras of Tepeucila. In the Codex of Quiotepec he appears as direct successor of Tecutochtli, so it is possible that this Codex was prepared by one of his scribes, and that the irrigated fields that appear in the center of the Codex are either the patrimonial lands over which he claimed control or the lands over which Quiotepec claimed control. Since the IPCCS gives Cuetlaxtecutli as son and successor of Tecuhtochtli, they may have been brothers.

DON GABRIEL DE MONJARAS
Appears in the AGN, Ramo de Indios (1591, 1618). Received the Governorship of Papalo from the corregidor, even though he had not been elected to the post. Kinsman (?) of the other Monjaras listed above. Received a tasación.

DON JUAN DE MONJARAS
Appears in the AGN, Ramo de Indios (1619). Was granted the right to use Spanish clothing, carry a sword, and mount a horse. Kinsman (?) of the other Monjaras listed above.

DOÑA MARTA DE ESPINOSA (Naghayg . . .)
Appears in the Codex de Quiotepec. Married to Francisco de Monjaras. Was baptized by Cortez. Lived ca. 1527.

JUANA DE SALAZAR
Appears in the Codex de Quiotepec and the AGN (1591). A homonym appears in the AGN (1575) as Cacica of Tonaltepec. Married (second wife?) Francisco de Monjaras, cacique of Quiotepec. Lived ca. 1523-1591. If both women are the same, she married the cacique of Quiotepec after the Tonaltepec husband's death. In 1591 claimed cacicazgo and land rights for her children from Monjaras, of Quiotepec.

DON MIGUEL DE MONJARAS
Appears in the AGN (1591). Father of Don Gabriel de Monjaras, cacique of Quiotepec-Papalo.

MARTIN MALDONADO
Appears in the AGN (1592-7). Cacique-Gobernador of Atlatlauca.

AVASLASLAC (Shining Snake)
Appears in the Relación de Guautla and Tutepetongo (1580). Lord of Tutepetongo before the Spanish Conquest. Was a Captain in Moctezuma II's army.

NOTES

1. "ycomo taues casiq^{z} Recojian los tributos q^{e} Ladha Estancia deYepaltepec da asu Mag. y despues de rrecotidos los juntan con los tributos decacalotepec p^{a}hos Entregarlos Alcasiq^{e} Gov. ^{or} destedho pueblo depapalo" (IPCCS: 21). "Al dho D^{n} Lorénzo y q. como tales caiq^{s} Recoxia los tributos de los naturales q– dedose aca ledan asu Mag en *rr* y deantes oro en polvo y q. lo mismo Recogieron sus antes pasados paraci y para Montesuma . . ." (IPCCS: 75).

2. "M^{te} se fundo por Guerras q^{e}hubo Con los delpueb^{o} dequotepec quienes querian Coger ypoblar En lastierras y agua de Cululapa y tecpanapa barranca de fuego quees *lla Duchi* hasta llano verde ladhagerra Gano El Casique destepueb^{o} depapalo ymando poblar la Estancia deyepaltepec Conyndios q^{e} saco delaEstancia deCacalotepec q^{e} entonses no se avia dividido" (IPCCS: 22).

3. "ypor El otrolado deldho Rio son sus tierras ymontes p^{r} loq. toca Elvarrio de tepa q^{s} Elmayor yprimero fundado" (IPCCS: 18).

4. "Gerras que tuvieron con Yndios masatecas del pueblo de quiotepec . . . agui paresieron presentes muchos yndios delpueblo dequiotepec ydijeron yamarse . . . y luego separlaron unos conlos otros EsuYdioma masateca y no quisieron acabar desir susnombres solo Dijeron son ofisiales de Republica yprinsipales desupueblo . . ." (IPCCS: 65).

5. "Los naturales depueb^{o} de quiotepec . . . pidieronal diho senor juez queden libres delapaga y ahendamiento delagua de aquilla Canada p^{r} que les ase notable falta para el Riego desus siembras Ensupueblo p^{r} que desde lagerraantigua nose aprovechan mas quepara sugasto ypara Regar ler ase D^{a} Catarina (cacica of Yepaltepec) primero Elpedir y pagar que el dho D^{n} Domingo hernandes Casiq^{e} de ellos y decacalotepec les a dado palabra de conseguir lacosa a favor de ellos . . ." "cobre lo cual Respondio El (. . . . . tequitlato?) dela dha estancia deyepaltepec no tener otra agua mas q^{e} el aRollo y que los antes pasados delos de quiotepec q^{e}daron vensidos q^{e} de las gerras se despoblaron y fueron Enlas tierras del salado a poblar yel dho casique D^{n}Diego dijo q^{e} Elagua Es suyo ysalia de susserros" (IPCCS: 32).

6. ". . . y que clarodan aentender enlas pinturas ymemorias quetrata La Generacion delos casiquez ysus sucesores Lafundacion dela dha Estancia deYepaltepec ydespues suDivision . . . ydise Este testigonotraterenganos las memorias ypinturas por q^{e} claro Consta demuchas cosas nacimientos Casamientos de los casiq^{z} muertes Gerras ysucesores" (IPCCS: 18). "yel dho senor Alcalde mayor mando Caminar para el poblado de ladha Estancia deyepaltepec para despuesvajar parellla no verdeq^{e} Esavajo deste primer Lindero y asi se toma el camino todo desuvida unaloma q^{e} Yaman . . . Laspiedras que consta Enlas dhas pinturas que Eneste lugar Estuvieronpara Determinar donde poblar" (IPCCS: 29).

7. "Los Linderos de las tierras del dho casicasgo de yelpaltepec q desde sus principios sefundo En unos solares de tierras visio las qeseve Entre ocotales y las Suertes de tierras q^{e} tiene son tres dos en una misma canada q^{e} son *Llayama lla duchi* tecpanapa barranca deFuego y *hico guilla* Cullulapa Esta un Rio pequeno q^{e} enambos Lados tiene sus sanjas quepor toda son siete Con la sanja delagua q^{e} pasa para El llano verde quees otra suerta detierra q^{e} se Riega conel mismo Rio pequeno sccoxe El agua y los montes sus En contornos que sirve para Las temporadas y nopaleras son estas sus linderos y dise Este t^{o} q^{e} por la parte devarrio detepa y qees del mismo Casique un Lado yotro pero que su antigua division yRaya de tierras Esun Rio q^{o} ase Eb medio q^{e} esta avajo deldho varrio mayor detepadeste ye Esta tambien abajo de la dha Estancia deyepaltepec en una canada y desde donde sale q^{e} is junto La Estancia dellanotiopa Colinda tepaltepec con la dha estancia Enuna pena blanca pegado al cerro *tao llaco* baja el Risco de Agua . . . alli Dise este est^{o} q^{e} llega El Rio pequeno de agua q^{e}baja del serro yepaltepec Con q^{e} Los naturales rriegan las tierras (. . . .) cullulapa yllano verde . . ." (IPCCS: 23-24).

8. "aqui sepasa El mismo aRollo de agua q^{e} nase del serro de Yepaltepec *hico llaa tay* yq^{e} sirve p^{a} El riego En las tierras de Cuyulapa tecpanapa varranca de fuego . . ." (IPCCS: 31-32).

9. "Las tierras de rriego q^{e} Encada ano Les Reparte El casique alos maseguales En deFerentes Lugares . . ." (IPCCS: 13). "y como tal cacique Repartia sus tierras y montes alos maceguales para sus siembras q^{e} los mudava Ende ferentes lugares en cada un año . . ." (p. 81).

10. "la estancia y varrio decaca lotepec y que es de los masequales que tiene acargo Eldho D^{n} Domingo . . ." (IPCCS: 62).

11. ". . . y anci me han echo ami Ladha sementera de mahis y me andado lo mismo desuvaluntad Como tienen de

Costumbre p^{r} Rason de Noblesa yp^{r} que noseles pide terrasgo nipago alguno delas tierras y agua que se sirven." "y ansi como estancia propiedad demaseguales que lo servian hacian Entierras propias Enterminos de la dha Estancia sierta sementera de mahis Encada un ano . . ." (IPCCS: 40).

12. "Dixo que los naturales de la estancia de Yepaltepec siempre han servido Al dho D^{n} Domingo de muchotiempo aestaparte y por Rason de se norio y Noblesa y porque les Reparte tierras alos masaquales Endeferentes lugares encada unano sin llevar cosa alguna . . ." (IPCCS: 61) ". . . y sus Antes pasados siempre les Reparten tierras alos masequales encada un ano endeferentes sitios y solares para sus siembras sin llevar pago alguno" (IPCCS: 72).

13. "q^{e} Como tales Casiquez acudian yacudieron los yndios a servirles . . . les reparaban sus Casas y lesdavan Yndios Endyas deservicio sementeras de Mahis gallinas y Cacao . . ." (IPCCS: 17). "desde sus antes pasados avidos ytenidos p^{r} tales casq^{z} y Nobles ycomunm^{te} Reputados p^{r} todos nosNaturales yprincipales destepueb^{o} y sus sujetos y Como atales acudian los Yndios Conservicios personales les Reparabansus Casas les acian sementerasdeMahiz yhuertas de frutales yatrosservicios de comida" (IPCCS: 21). "Lecervian aciendole sus sementeras Paparando las casas aves cacao y mantas yotras cosas parasy comida y que En las fiestas ledavan mantas y prisientes que ya manda Como espublico y Notorio que los Yndios quanto tenian *boluntariamente* davan a sus casiques" (IPCCS: 75) (italics ours).

14. ". . . DnaCatarina a Tepeusila donde tiene su casicasgo tierras y pueblos oy encargado a un D^{n} Pedro demonjaras supariente y q. le dexaron dar el servisio mientras estubo ausente" (now living in Papalo) (IPCCS: 86). "Que don Marcos de Aguila Yndios governador del pueblo de Papaloticpac me a fecho rrelacion que pretendiendo ser tenido y obedicido por cacique del dicho pueblo donde lo es y fueron sus pasados gano un Mandamiento . . . y que por estar impedido en esta ciudad (Teutila) no asiste en su cargo ni a cumplido el dicho Mandamiento y que de las dilacion se le siguen mucho dano por dexar de gozar los servicios personales y socovios . . ." (AGN, Ramo de Indios: Vol. 2, Exp. 74 [foja 18r-18v], 1582).

15. "los Casiq^{z} todos son seuna Casa y como hasi se rreconosen Deudos oy los casiques destepueblo Con loscasiq^{z} de los pueblos comarcanos y consta Enlas dhas pinturas que son decendientes de Reyes de aguellos tiempos y descendientes de un solo casiq^{e} q^{e} fue dueno de toda esta jurisdicion . . ." (IPCCS: 22).

16. "este (testigo) aoydo antepasados decir tratan las pinturas pero este confesante no aprendio ni save el computo delos a fha ni ystoria de las pinturas pero por los versos y cantares save . . ." (D. Hernandez, *indio natural* of the *barrio* of Huiztepec) (IPCCS: 88). This information is interesting because it points out that the Cuicatec commoners could not read the native writing, but that the masses memorized their history in metric verses which facilitated recall. Probably, as in the case of the Nahuatl, these poetic texts accompanied recall in codex reading, and expanded the limited textual value of Cuicatec pre-Hispanic writing, when used by the experts (Cornyn 1926: 463-473).

17. "y estos generos de cosas las iban a busear a otros pueblos los yndios, y las rescatuan a trueque de unas mantillas de algodon del tamano de un pliego de papel, que corria entre ellos por moneda" (*PNE*, IV: 165).

18. "y que avian pasado despues aca desupoblacion diez vidas de hombres y que el Casique . . . poblo la estancia" (IPCCS: 63). "Q despues aver pasado sinco siglos de asinquenta y dos anos cada siglohubo un cacique . . ." (IPCCS: 80).

19. "Q despes aver pasado sinco siglos de asinquenta y dos anos cada siglo hubo un casique que . . . caso dos veces y concada muger tuvo un hijo primero con la casicadequotepec y despues con la hija del casique delasestancia de teotila el hijo con la primera muger le cupo el casicazgo de su M^{e} q. es quiotepec sus tierras y pueblos salado ytecomavaca elqual generacion prosede oy la muger del dho D^{n} Domingo auntor deste pleito y q^{e} eldho primer hijo por ciclaltecutli su padre eredo nas estancias decacalotepec y comaltianguisco y el dho hijo de ciclaltecutli con la dha segunda muger eredo la estancia de Yepaltepec del cual generacion fue el dho D^{n} Lorenzo" (IPCCS: 80).

20. "Divido el dho citlaltecutli porq. secaso dos veses y Concada muger tubo un hijo . . . el dho citlaltecutli hijo suyo conla primera muger por la dha casica su madre eredo el casicasgo de quiotepec salado y tecomavaca y por su dho padre Eredo las estancias decacalotepec y Comaltianguisco" (IPCCS: 100). "Despuesdemucho tiempo desufundacion huvo un casique q^{e} leavia tres estancias con Eldho Yepaltepec . . . de Cuya generacion diciente oy Eldho D^{n} GiegoXimenez pues q^{e} por lignea Recta es suyo y lecompeta elcasicasgo" (IPCCS: 23).

21. "la Casica dequiotepec secaso con citlaltecutli Casique deste pueblo p^{r} apasiguar sierta rrina q/ desde la fundacion de Yepaltepec tubo quiotepec conestepue^{o} depapalo" (IPCCS: 67). "q^{e}lecassase D^{n} Lorenzo con D.a Catarina p^{r} q^{e} D^{n} Matintoxtecutli padre de D^{n} Lorenzo y D^{n} Miguel Cuyancan detepeuzila padre deladha D^{a} catarina Eranparientes sercano yestavan Enpleyto sobre El casicasgo de tepeuzila po^{r} alegar majpr Dro El deste pue^{o} depapalo ypor pasiguar seconcerto El casa m^{t} de D^{n} Lorenzo ConD^{a}Catarina" (IPCCS: 9).

ABBREVIATIONS USED IN THE BIBLIOGRAPHY

AA	*American Anthropologist*, American Anthropological Association, Menasha, Wisconsin.
Amer. Antiq.	*American Antiquity*, The Society for American Archaeology, Menasha, Wisconsin and Salt Lake City, Utah.
APS, T	*Transactions of the American Philosophical Society,* Philadelphia.
AL	*Anthropological Linguistics*, Bloomington, Indiana.
AGN	Archivo General de la Nación, Mexico City.
BAE, P	*Publications of the Bureau of American Ethnology*, Smithsonian Institution, Washington, D. C.
CIW	Carnegie Institution of Washington, Washington, D. C.
ENE	*Epistolario de la Nueva España*, Paso y Troncoso (Ed.), 1939-42.
HMAI	*Handbook of Middle American Indians*, Robert Wauchope, General Editor, University of Texas Press, Austin, Texas.
HAHR	*Hispanic American Historical Review*, Duke University Press, Durham, North Carolina.
IA	*Ibero-Americana*, Berkeley and Los Angeles, California.
INAH, A	*Anales del Instituto Nacional de Antropología e Historia,* Mexico.
INI	Instituto Nacional Indigenista, Mexico.
ICA	International Congress of Americanists.
IJAL	*International Journal of American Linguistics*, Bloomington, Indiana.
MNAH	Museo Nacional de Antropología e Historia, Mexico.
NWAF, P	*Papers of the New World Archaeological Foundation,* Orinda, California, and Brigham Young University, Provo, Utah.
NS12	Nobel Symposium 12, *Radiocarbon Variations and Absolute Chronology,* Olsson (Ed.), 1970.
PNE	*Papeles de la Nueva España,* Paso y Troncoso (Ed.), 1905.
PMAAE, R	*Reports of the Peabody Museum of American Archaeology and Ethnology,* Cambridge, Massachusetts.
Radiocarbon	*Radiocarbon Supplement*, *American Journal of Science*, New Haven, Connecticut.
RMEA	*Revista Mexicana de Estudios Antropológicos*, Mexico.
RSPFA, P	*Papers of the Robert S. Peabody Foundation for Archaeology,* Phillips Academy, Andover, Massachusetts.
SAA, M	*Memoirs of the Society for American Archaeology,* Menasha, Wisconsin, and Salt Lake City, Utah.
SJA	*Southwestern Journal of Anthropology*, Albuquerque, New Mexico.
VFPA	*Viking Fund Publications in Anthropology*, New York.

BIBLIOGRAPHY

Abdel-malek, Anouar

1962 *Égypte, Société Militaire.* Paris.

Acosta, Jorge R.

1965 "Preclassic and Classic Architecture of Oaxaca." *HMAI*, 3:814-836.

Adams, Robert McC.

1956 "Some Hypotheses on the Development of Early Civilizations." *Amer. Antiq.*, 21 (3):227-232.

1960 "The Origin of Cities." *Scientific American*, 203 (3).

1966 *The Evolution of Urban Society: Early Mesopotamia and Prehispanic Mexico.* Chicago: Aldine Publishing Co.

Adan, Elfego

1922 "Los Cuicatecos Actuales." *Anales del Museo Nacional (Mexico)* 4a. Epoca. I:137-154.

Alvarado, Fr. Francisco de

1593 Vocabulario en Lengua Misteca. Mexico: Casa Pedro Balli. Reprinted in Jiménez Moreno (Ed.), *Estudios Mixtecos,* INI and INAH (1962).

Amer, Ibrahim

1958 *The Land and the Fellah: The Agrarian Question in Egypt.* Cairo.

Anales de Cuauhtitlan y Leyenda de los Soles (Codex Chimalpopoca)

1945-47 Mexico: Antigua Librería Robledo.

Anales de Tlatelolco y Códice de Tlatelolco, see Berlin, H., and R. H. Barlow (Eds. and commentators)

Andrews, E. Wyllys

1965 "Archaeology and Prehistory in the Northern Maya Lowlands." *HMAI*, 2:288-330:

Angulo y Mayo, Jaime, and L. S. Freeland

1933-34 "The Zapotekan Linguistic Group: A Comparative Study of Chinantec, Chocho, Mazatec, Cuicatec, Mixtec, Chatino and especially of Zapotec Proper and Its Dialects." *IJAL*, VIII: 1-38.

Arana Osnaya, Evangelina

1959 *Relaciones Internas del Mixteco-Trique. INAH, A,* 12: 219-273.

1960 *El Idioma de los Señores de Teposcolula. INAH, A,* 13: 217-230.

———, and Mauricio Swadesh

1965 *Los Elementos del Mixteco Antiguo.* INI and INAH.

Archivo General de la Nación (AGN), Bulletin, *see* Boletin del AGN; Publications, *see* Publicaciones del AGN. *See also* Unpublished References, p. 249, this volume.

Armendaris, Eduardo

1902 *Estudio sobre las Aguas de Tehuacán, Estado de Puebla.* Secretaría de Fomento, Colonización e Industria. Instituto Médico Nacional. Mexico, D. F.

Armillas, Pedro

1948 "A Sequence of Cultural Development in Mesoamerica." *A Reappraisal of Peruvian Archeology,* ed. by W. C. Bennett. *SAA, M,* no. 4.

1949 *Notas sobre Sistemas de Cultivo en Mesoamerica: Cultivos de Riego y Humedad en la Cuenca del Río de las Balsas. INAH, A,* 3: 85-113.

1961 "Land Use in Pre-Columbian America." *A History of Land Use in Arid Regions,* Stamp (Ed.). UNESCO, Arid Zone Research, No. 17, pp. 255-276.

1964 "Northern Mesoamerica." *Prehistoric Man in the New World,* ed. by J. D. Jennings and E. Norbeck. Chicago: University of Chicago Press.

———, Á. Palerm, and E. R. Wolf

1956 "A Small Irrigation System in the Valley of Teotihuacan." *Amer. Antiq.*, 21: 396-399.

Arnold, J. R., and W. F. Libby

1950 *Radiocarbon Dates.* Institute for Nuclear Studies. Chicago: University of Chicago Press.

Arzobispo de México

1560 Memoria de las Provincias y Pueblos que Están en su Cabeza de su Magestad en la Nueva España . . . . *ENE,* IX: 43-49.

Ascher, Marcia, and Robert Ascher

1963 "Chronological Ordering by Computer." *AA,* 65: 1045-1052.

Asin, J. Oliver

1959 *Historia del Nombre "Madrid."* Consejo Superior del Investigaciones Científicos. Instituto Miguel Asin. Madrid.

Attolini, José

1949 *Economía de la Cuenca del Papaloapan: Agricultura.* Instituto de Investigaciones Económicas. Mexico.

1950 *Economía de la Cuenca del Papaloapan: Bosque,* *Fauna, Pesca, Ganadería e Industria.* Instituto de Investigaciones Económicas. Mexico.

Aveleyra A. de Anda, Luis
1956 "The Second Mammoth and Associated Artifacts at Santa Isabel, Iztapan, Mexico." *Amer. Antiq.*, 22:12-28.
1962 *Antigüedad del Hombre en México y Centroamerica.* Cuadernos del Instituto de Historia, Serie Antropológica no. 14. Mexico.

Baez, Victoriano
1909 *Compendio de Historia de Oaxaca.* Oaxaca, Mexico.

Bandelier, Adolph E.
1877 *On the Art of War and Mode of Warfare of the Ancient Mexicans. PMAAE, R,* II.
1878 *On the Distribution and Tenure of Land, and the Customs with respect to Inheritance, among the Ancient Mexicans. PMAAE, R,* II.

Barlow, Robert H.
1943 "The Eighteenth Century Relaciones Geográficas." *Tlalocan*, I (1): 54-70.
1944 Review of J. Barr Tompkins, "Codex Fernandez Leal," in the Pacific Art Review. *Tlalocan*, I (4): 383-384.
1949 "The Extent of the Empire of the Colhua Mexica." *IA*, no. 28.
——— (Ed.)
1962 "Relación de Cuilapa." *Boletín de Estudios Oaxaquenos*, no. 23. Mexico.

Basauri, Carlos
1928 *La Situación Actual de la Población Indígena de México.* Mexico, Publicaciones de la Secretaría de Educación Publica, vol. XVI, no. 8.
1940 *La Población Indígena de México.* 3 vols. Mexico.

Basham, A. L.
1959 *The Wonder That was India.* New York.

Bassadre, Jorge
1956 *Los Fundamentos de la Historia del Derecho.* Lima.

Bateson, Gregory
1958 *Naven.* Stanford: Stanford University Press.

Beardsley, Richard K., John W. Hall, and Robert E. Ward
1959 *Village Japan.* Chicago: University of Chicago Press.

Beckett, Philip
1953 "Qanats around Kirman." *Royal Central Asian Journal*, 40 (1):47-58. London.

Belmar, Francisco
1901 *Reseña Histórica y Geográfica del Estado de Oaxaca.* Oaxaca, Mexico: Imprenta de Comercio.
1902 *El Cuicateco.* Oaxaca, Mexico: Imprenta de Comercio.
1905 *Las Lenguas Indígenas de México.* Mexico.

Beloch, Julius
1886 *Die Bevoelkerung der griechisch-roemischen Welt.* Leipzig.

Bémont, Frédy
1961 "l'Irrigation en Iran." *Annales de Géographie* 70: 597-620. Paris.

Berger, Rainer, John A. Graham, and Robert F. Heizer
1967 "A Reconsideration of the Age of the La Venta Site." *Studies in Olmec Archaeology.* Contributions of the Univ. of Cal. Arch. Research Facility, no. 3, pp. 1-24. Berkeley.

Berger, Rainer, and W. F. Libby
1966 "U.C.L.A. Radiocarbon Dates V." *Radiocarbon* 8: 467-497.

Berlin, Heinrich
1947 *Fragmentos Desconocidos del Códice de Yanhuitlan y otras Investigaciones Históricas.* Mexico: Antigua Librería Robledo.

Berlin, H., and R. H. Barlow (Eds. and commentators)
1948 *Anales de Tlatelolco: Unos Annales (sic) Históricos de la Nación Mexicana y Códice de Tlatelolco.* Mexico: Antigua Librería Robledo.

Berlin, H., and Paul Kirchhoff (Eds. and commentators)
1947 *Historia Tolteca-Chichimeca.* Mexico: Antigua Librería Robledo.

Bernal, Ignacio
1962 "Relación de Guautla." *Tlalocan*, 4 (1): 3-16.
1965*a* "Archaeological Synthesis of Oaxaca." *HMAI*, 3: 788-813.
1965*b* "Teotihuacan: Nuevas Fechas de Radiocarbono y su posible Significado." *Anales de Antropología* 2:27-35.

Bernheim, Ernst
1908 *Lehrbuch der Historischen Methode und der Geschichtsphilosophie*, 1. Leipzig.

Bevan, Bernard
1938 *The Chinantec and Their Habitat*, vol. 1. Instituto Panamericano de Geografía y Estadística, Pub. No. 24. Mexico.

Binford, Lewis
1968 "Some Comments on Historical vs. Processual Archaeology." *SJA*, 24 (3): 267-275.

Blasquez L., Luis
1957 "Hidrogeología de una Parte del Valle Tehuacán, Estada de Puebla." *Anales del Instituto de Geología* 12 *(Estudios Hidrogeológicos)*: 9-55.

Boletin del AGN
Indice del Ramo de Tierras. División Política de la Nueva España en 1786. Real Ordenanza de Intendentes.
1940 Tributos de Indios. Una Relación Sacada de los Libros de S. M. en enero de 1560, del Valor de lo que Producen los Pueblos de Indios de Nueva España. Vol. XI (2): 199-243.

Borah, Woodrow, and Sherburne F. Cook
1958 “Price Trends of Some Basic Commodities in Central Mexico, 1531-1570.” *IA*, no. 40.

Borhegyi, Stephan de
1965 “Archaeological Synthesis of the Guatemalan Highlands.” *HMAI*, 2: 3-58.

Bowman, Isaiah
1924 “Desert Trails of Atacama.” *American Geographical Society, Special Pub.* no. 5. New York.

Bradomín, José Maria
1955 *Toponímia de Oaxaca.* Mexico.

Brainerd, George W.
1951 “The Place of Chronological Ordering in Archaeological Analysis.” *Amer. Antiq.*, 16: 301-313.

Bravo, Helia H.
1960 “Algunos Datos acerca de la Vegetación del Estado de Oaxaca.” *RMEA*, 16: 31-47.

Brunet, Jean
1967 “Geologic Studies.” *The Prehistory of the Tehuacan Valley*, vol. 1, *Environment and Subsistence*, ed. by D. S. Byers. Austin: University of Texas Press.

Brush, Charles F.
1965 “Pox Pottery: Earliest Identified Mexican Ceramic.” *Science*, 149: 194-195.

Buiza, Alonso de
1551 Carta al Presidente del Consejo de Indias, de . . . Regidor de Los Angeles (Puebla) suplicando . . . *ENE* V: 57-59.

Burgoa, Francisco
1670 Palestra Historial de Virtudes y Ejemplares . . . de la Orden de Predicadores . . . Mexico. AGN (3rd. ed.), no. 24. (1934 ed.)
1674 Geográfica Descripción . . . de esta Provincia de Antequera Valle de Guaxaca. 2 vols. AGN, Nos. XXV-XXVI. (1934 ed.)

Burland, Cottie A., and G. Kutscher (Eds.)
1955 *The Selden Roll.* Verlag Gerb. Mann. Americana II. Berlin.

Butler, Millard A.
1933 “Irrigation in Persia by Kanáts.” *Civil Engineering*, 3: 69-73.

Buttinger, Joseph
1958 *The Smaller Dragon: A Political History of Vietnam.* New York.

Byers, Douglas S.
1967 “The Region and Its People.” *The Prehistory of the Tehuacan Valley*, vol. 1, *Environment and Subsistence*, ed. by D. S. Byers. Austin: University of Texas Press.

——— (Ed.)
1967 *The Prehistory of the Tehuacan Valley*, vol. 1, *Environment and Subsistence.* Austin: University of Texas Press.

Calnek, Edward E.
1960 “Salinity, Chinampa Agriculture and the Urban Development of Tenochtitlan Tlatelolco.” M. A. Thesis. Department of Anthropology, University of Chicago.
1963 “Highland Chiapas Before the Spanish Conquest.” Ph.D. Dissertation. University of Chicago.
1969*a* “Dynastic Succession in Aztec Society.” Paper read at the Annual Meeting of the American Society for Ethnohistory, Ithaca, New York.
1969*b* “Urbanization at Tenochtitlan.” Paper read at the 68th Annual Meeting of the American Anthropological Association, New Orleans, La.

Carrasco, Pedro
1950 *Los Otomíes: Cultura e Historia Prehispánica de los Pueblos Mesoamericanos de Habla Otomiana.* Instituto de Historia, Mexico.
1959 *Land and Polity in Tibet.* Seattle, Wash.
1961 “The Civil-Religious Hierarchy in Mesoamerican Communities: Pre-Hispanic Background and Colonial Development.” *AA*, 63 (3): 483-497.

Caso, Alfonso
1953 *El Pueblo del Sol.* Fondo de Cultura Económica, Mexico.
1958 “Comentario al Códice Baranda.” In *Miscelánea Paul Rivet*, pp. 373-393. XXXI ICA. University of Mexico.
1959 *La Tenencia de la Tierra entre los Antiguos Mexicanos. Memoria del Colegio Nacional de México*, vol. 4, no. 2.
1960*a* Interpretation of the Bodley Codex, Bodleian Library. Sociedad Mexicana de Antropología, Mexico.
1960*b* The Historical Value of Mixtec Códices. *Boletín de Estudios Oaxaqueños*, no. 16.
1961 *Los Lienzos mixtecos de Ihuitlan y Antonio de León. Homenaje a Pablo Martínez del Río*, p. 237. Mexico.
1963 “Land Tenure among the Ancient Mexicans.” *AA*, 65 (4): 863-868.
1965*a* “Mixtec Writing and Calendar.” *HMAI*, 3: 948-961.
1965*b* “Zapotec Writing and Calendar.” *HMAI*, 3: 931-947.
1966 “The Lords of Yanhuitlan.” In Paddock (Ed.), *Ancient Oaxaca*, pp. 313-335. Stanford: Stanford University Press.

——— (Ed.)
1964 *Codex Selden.* Sociedad Mexicana de Antropología, Mexico.

———, and Ignacio Bernal
1965 “Ceramics of Oaxaca.” *HMAI*, 3: 871-895.

Castañeda, C. E., and J. A. Dabbs
1939 *Guide to the Latin American Manuscripts in the University of Texas Library.* Committee on Latin American Studies, Misc. Pub. No. 1. Austin: University of Texas Press.

Castañeda, Francisco de

1581 Relación de Teotitlan del Camino. *PNE*, IV (segunda serie).

Castañeda Leon, J. de

1580 Relación de Coxcatlan. *PNE*, III: 46-54.

Cerda Silva, Roberto de la

1942 "Los Cuicatecos." *Revista Mexicana de Sociología*, 4: 99-127.

Cervantez de Salazar

1914 *Crónica de la Nueva España* (tercera serie). vols. I and III. Manuscrito 2011 de la Biblioteca Nacional de Madrid. Letra de la mitad del Siglo XVI.

Chamberlain, Robert S.

1939 "The Concept of Señor Natural." *HAHR*, 19: 130-137.

Chavero, Alfredo

1892 *Códice Porfirio Diaz*. Mexico, Junta Colombina, Homenaje a Cristobal Colón. Lithography by G. Lopez. Antigüedades Mexicanas, Litografía del Timbre.

Chavez Orozco, Luis

1943 "Las Instituciones Democraticas de los Indígenas Mexicanos en la Época Colonial." *America Indígena*, 3: 73-82, 161-171, 265-276, 365-382.

1951-53 Indice del Ramo de Indios del AGN. Vol. I, published by AGN. Vol. II, published by Instituto Indigenista Interamericano (special edition).

Childe, V. Gordon

1936 *Man Makes Himself*. London: Watts & Co.

1942 *What Happened in History*. New York: Penguin Books, Inc.

Clark, J. C. (Ed. and translator)

1938 *Codex Mendocino* (Codex Mendoza). 3 vols. London: Waterlow.

Clark, John Grahame Douglas

1960 *Archaeology and Society*. New York: Barnes and Noble.

Cline, Howard F.

1956 "The Chinantla of Northeastern Oaxaca, Mexico." *Estudios Antropológicos, Publicados en Homenaje al Doctor Manuel Gamio*, pp. 635-656. Mexico.

1957 "Problems of Mexican Ethnohistory: The Ancient Chinantla, a Case Study." *HAHR*, 37: 273-295.

1963 *Lienzos y Communidades Mazatecas de la Época Colonial, Oaxaca, Mexico*. XXXV, ICA. pp. 397-424. Mexico.

1966 "Native Pictorial Documents of Eastern Oaxaca, Mexico." In *Suma Antropológica en Homenaje a Roberto J. Weitlaner*. INAH.

——— (Ed.)

1961 *Papeles de la Chinantla III*. Notas y Apendices de la Re-Edición de Mariano Espinosa (1910), "Apuntes Históricos de las Tribus Chinantecas, Mazatecas y Popolucas." MNAH, Serie Científica.

Codex Baranda (or Alvarado?)

Post-Hispanic (dated?). Impreso por Lit. del Timbre s.f. — Mexico (original in the MNAH).

Codex Chimalpopoca, *see Anales de Cuauhtitlan y Leyenda de los Soles*

Codex Fernandez Leal, *see* Peñafiel, Antonio (Ed.)

Codex Mendocino (Codex Mendoza), *see* Clark, J. C. (Ed. and translator)

Codex Porfiro Diaz, *see* Chavero, Alfredo

Coe, Michael D.

1965 "Archaeological Synthesis of Southern Veracruz and Tabasco." *HMAI*, 3: 679-715.

———, Richard A. Diehl, and Minze Stuiver

1967 "Olmec Civilization, Veracruz, Mexico: Dating of the San Lorenzo Phase." *Science*, 155: 1399-1401.

Coe, William R., and Robert Stuckenrath, Jr.

1964 *A Review of La Venta, Tabasco, and Its Relevance to the Olmec Problem. Kroeber Anthropological Society, Papers*, no. 31, pp. 1-43. Berkeley.

Comisión del Papaloapan

1954 *Reconocimiento General del Alto Papaloapan. Primera Parte, Subcuenca del Río Salado*. Estudios y Proyectos A. C. Mexico.

1956*a* *Atlas Climatológico e Hidrológico de la Cuenca del Papaloapan*. Secretaría de Recursos Hidráulicos. Estados Unidos Mexicanos. Mexico.

1956*b* Topographic maps, revised, scale 1:50,000. Sheets 11, 19, 20, 29, 38, 39. Estudios y Proyectos A. C. Mexico.

Cook, Sherburne F.

1949 "Soil Erosion and Population in Central Mexico." *IA*, no. 34.

1958 "Santa Maria Ixcatlan: Habitat, Population, Subsistence." *IA*, no. 41.

Cornyn, Hubert J.

1926 *Aztec Metric Literature*. XII, ICA, II: 463-473. Rome.

Cortés, Hernán

1942 *Cartas de Relación de la Conquista de Méjico*. Madrid.

Crane, H. R., and James B. Griffin

1958 "University of Michigan Radiocarbon Dates III." *Science*, 128: 1117.

Cressey, George B.

1958 "Qanats, Karez, and Foggaras." *Geographical Review*, 48: 27-44.

Cruxent, José M., and Irving Rouse

1956 "A Lithic Industry of Paleo-Indian Type in Venezuela." *Amer. Antiq.*, 22: 172-179.

Dahlgren de Jordan, Barbro

1954 *La Mixteca: Su Cultura e Historia Prehispánica*. Mexico: Imprenta Universitaria.

1962 *La Grana Cochinilla*. Nueva Biblioteca Mexicana de Obras Históricas. Mexico: José Porrua e Hijos.

Dalton, George

1965 "Primitive Money." *AA*, 67: 44-65.

Damon, P. E.
1968 *Radiocarbon and Climate.* Meteorological Monographs, 8: 151-154.
———, A. Long, and D. Gray
1966 "Fluctuations of Atmospheric C14 during the Last Six Millenia." *Jour. Geophys. Research,* 71: 1055-1063.

Dark, Philip
1957 "Methods of Synthesis in Ethnohistory." *Ethnohistory,* 4 (3): 231-278.

Davis, Marjorie
1952-58 *Cartillas I-IV.* Instituto Lingüístico de Verano.
1954 "Translating from FM Cuicatec to TL English." *IJAL,* 20 (4): 302-312.
1963 "Cuicatec Tales about Witchcraft." *Tlalocan,* IV (3): 197-203.
———, and Margaret Walker
1955 "Cuicatec: Morphemics and Morphophonemics." *IJAL,* 21: 46-51.

de Vries, Hessel
1958 *Variation in Concentration of Radiocarbon with Time and Location on Earth.* Koninkl. Ned. Akad. Wet. Proc. Ser. B, 61: 94-102. Amsterdam.

Diakonoff, I. M. (Ed.)
1969 *Ancient Mesopotamia, Socio-Economic History: A Collection of Studies by Soviet Scholars.* Moscow.

Dibble, Charles E.
1940 "El Antiguo Sistema de Escritura en México." *RMEA,* IV (1-2): 105-128.
——— (Ed.)
1951 *Códice Xolotl.* Universidad Nacional Instituto de Historia. ser. I, no. 22. Mexico.

Dixon, Keith A.
1959 *Ceramics from Two Preclassic Periods at Chiapa de Corzo, Chiapas, Mexico. NWAF, P,* no. 5.

Dozier, Edward P.
1961 "Rio Grande Pueblos." *Perspectives in American Indian Culture,* ed. by Edward H. Spicer. Chicago.
1970 *The Pueblo Indians of North America.* New York: Holt, Rinehart, & Winston.

Durkeim, Émile
1883 *The Division of Labor in Society.* Glencoe, Illinois: The Free Press. (1966 ed.)
1953 *Montesquieu et Rousseau.* Paris.

Ellis, William
1826 *Narrative of a Tour Through Hawaii, or Owhyhee.* London.

Engels, Friedrich
1884 *The Origin of the Family, Private Property, and the State.* Zurich.

Epistolario de la Nueva España (ENE), see Paso y Troncoso, Francisco del

Erasmus, Charles J.
1965 "Monument Building: Some Field Experiments." *SJA,* 21: 277-301.

Espinosa, Mariano
1910 "Apuntes Históricos de las Tribus Chinantecas, Mazatecas y Popolucas." *Papeles de la Chinantla III,* ed. by H. F. Cline. MNAH. Serie Científica. (1934, 1961 eds.)

Esteva, Cayetano
1913 *Nociones Elementales de Geografía Histórica del Estado de Oaxaca.* Oaxaca, Mexico: Tipografía de San German Hermanos.

Evans-Pritchard, E.
1940 *The Nuer.* London.

Eyre, John D.
1955 "Water Controls in a Japanese Irrigation System." *The Geographical Review,* 45: 197-216.

Ferguson, C. W.
1968 "Bristlecone Pine: Science and Esthetics." *Science,* 159: 839-846.
1970 "Dendrochronology of Bristlecone Pine, *Pinus aristata.*" NS12, pp. 237-260.

Fernandez Contreras, Juan
1934 "La Cura Hidromineral en Tehuacán en las Enfermedades del Higado y Vias Biliares, sus Indicaciones y Contraindicaciones." Prueba Escrita para el Exámen de Médico Cirujano, Universidad Nacional Autónoma, Facultad de Medicina. Mexico.

Fernea, Robert A.
1963 "Conflict in Irrigation." *Comparative Studies in Society and History,* VI: 76-83.

Fick, Richard
1920 *The Social Organisation in North-East India in Buddha's Time.* Calcutta.

Field, Chris
1966 "A Reconnaissance of Southern Andean Agricultural Terracing." Ph.D. dissertation. Department of Geography, University of California, Los Angeles.

Flannery, Kent V.
1967 "The Vertebrate Fauna and Hunting Patterns." *The Prehistory of the Tehuacan Valley,* vol. 2, *Nonceramic Artifacts.* Austin: University of Texas Press.
———, *et al.*
1967 "Farming Systems and Political Growth in Ancient Oaxaca." *Science,* 158 (3800): 445-454.

Forbes, R. J.
1955 "The Qanat and the Birth of the Aqueduct." *Studies in Ancient Technology,* 1: 152-159. Leiden.

Ford, James Alfred
1962 "A Quantitative Method for Deriving Cultural Chronology." *Technical Manual 1.* Washington, Pan American Union.

Fortes, Meyer
1953 "The Structure of Unilineal Descent Groups." *AA,* 55: 17-41.

Gallego, Juan

1580 Relación de Cuicatlan. *PNE,* IV: 183-189. (1914 ed.)

Galvan Rivera, Mariano

1870 *Concilio Provincial Mexicano.* (Mexico 1585.) Barcelona.

Ganshof, F. L.

1961 *Feudalism.* New York: Harper Torchbooks.

Garibay K., Angel María

1582 Relación de Juan Bautista de Pomar. *Commentary on Nahuatl Poetry,* vol. 1. Universidad Nacional Instituto de Historia (1964 ed.). Mexico.

García Granados, Rafael

1935 "Contribución para la Geografía Etnográfica y Lingüística de Oaxaca." *Boletín de la Soc. Mex. de Geografía y Estadística,* vol. 44 (10): 401-410.

1953 *Diccionario Biográfico de Historia Antigua de México.* 3 vols. Instituto de Historia Mexico.

García Pimentel, Luis (Ed.)

1904 "Relación de los Obispados de Oaxaca, Tlaxcala, Michoacán y otros Lugares." *Documentos Históricos de México.* 190 pages.

Gay, Padre José Antonio

1881 *Historia de Oaxaca.* (Original publication in two volumes; 1950 ed. published in four volumes: Volumen 1 Tomo I, Volumen 2 Tomo I, Volumen 1 Tomo II, and Volumen 2 Tomo II. Pagination follows continuously for the first two volumes, and starts again with Vol. 3, i.e., Vol. 1, Tomo II, through Vol. 4.) Biblioteca de Autores de Asuntos Oaxaqueños. Talleres V. Venero, Mexico. (1950 ed.)

Geertz, Clifford

1959 "Form and Variation in Balinese Village Structure." *AA,* 61 (6): 991-1012.

1963 *Peddlers and Princes.* Chicago: University of Chicago Press.

Gibson, Charles

1948 *The Inca Concept of Sovereignty and the Spanish Administration in Peru.* Institute of Latin American Studies, no. 4. Austin: University of Texas Press.

1952 *Tlaxcala in the Sixteenth Century.* New Haven: Yale University Press.

1964 *The Aztecs Under Spanish Rule.* Stanford: Stanford University Press.

Gil Huerta, Gorgonio, and James A. Neely

1967 "Historia de la Fundación del Pueblo de San Gabriel Chilacatla." *Tlalocan,* V, no. 3: 198-219.

Glass, John B.

1964 *Catálogo de la Colección de Códices.* INAHMNA.

Glick, Thomas

1970 *Irrigation in Medieval Valencia.* Cambridge: Harvard University Press.

Godwin, Harry

1962 "Half Life of Radiocarbon." *Nature,* 195: 984.

Goldfrank, Esther S.

1945 "Socialization, Personality, and the Structure of Pueblo Society." *AA,* vol. 47, no. 4.

Gray, Robert F.

1963 *The Sonjo of Tanganyika: An Anthropological Study of an Irrigation-based Society.* London, New York, Toronto.

Green, D. F., and Gareth W. Lowe

1967 *Altamira and Padre Piedra: Early Preclassic Sites in Chiapas, Mexico. NWAF, P,* No. 20.

Greene, Herbert

1966 "Irrigation in Arid Lands." *Arid Lands: A Geographical Appraisal,* ed. by E. H. Hills, pp. 255-271. London: Methuen and UNESCO, Paris.

Gutmann, Bruno

1926 *Das Recht der Dschagga.* Munich.

Haynes, C. Vance, Jr., A. R. Doberenz, and J. A. Allen

1966 "Geological and Geochemical Evidence Concerning the Antiquity of Bone Tools from Tule Springs, Site 2, Clark County, Nevada." *Amer. Antiq.,* 31: 517-521.

Hegel, Georg Wilhelm Friedrich

1919 *Vorlesungen ueber die Philosophie der Weltgeschichte. Saemtliche Werke,* Lasson, Ed. Leipzig.

Heizer, Robert F., and James A. Bennyhoff

1958 "Archeological Investigation of Cuicuilco, Valley of Mexico, 1957." *Science,* 127: 232-233.

Herold, Laurance C.

1965 *Trincheras and Physical Environment along the Rio Gavilan, Chihuahua, Mexico. Publications in Geography,* Technical Paper no. 65-1. University of Denver.

Herrera, Antonio de

1726 *Historia General de los Hechos de los Castellanos en las Islas y Tierra Firme del Mar Oceano.* Publicada por acuerdo de la Academia de la Historia. Tipografía de Archivos. 13 vols. (1934 ed.) Madrid.

Hidalgo Fuentelsaz, Manuel G.

1958 "Geohidrología y Estimación de los Volúmenes de Aguas en el Subsuelo del Valle de Tehuacán, Puebla." Thesis, Universidad Nacional Autónoma de México (para el grado de "Ingeniero Geólogo"), Escuela Nacional de Ingenieros, México, D. F.

Holland, William R.

1959 "Dialect Variations of the Mixtec and Cuicatec Areas of Oaxaca, Mexico." *AL,* I (8): 25-31.

Hopkins, Edward W.

1902 *India Old and New.* New York and London.

Hunt, Eva

1969 "The Meaning of Kinship in San Juan: Genealogical and Social Models." *Ethnology,* vol. 8, no. 1: 37-53.

n.d. "Kinship and Territorial Fission in the Cuicatec

Highlands." *Kinship and Social Organization in Mesoamerica*, ed. by H. Nutini. In press.

———, and Robert Hunt

1968 "The Role of Local Courts in Rural Mexico." *Peasants in the Modern World*, ed. by Philip K. Bock. Albuquerque: University of New Mexico Press.

———, and June Nash

1967 "Territorial and Local Units in Middle America." *HMAI*, 6: 253-282.

Hunt, Robert

1965 "The Developmental Cycle of the Family Business in Rural Mexico." *Essays in Economic Anthropology*, ed. by J. Helm. Proceedings of the Annual Meeting of the American Ethnological Society, pp. 54-79. Seattle: University of Washington Press.

1968 "Agentes Culturales Mestizos: Estabilidad y Cambio en Oaxaca." *América Indígena*, 28: 595-609.

1971 "Components of Relationships in the Family: A Mexican Village." *Kinship and Culture*, ed. by F. L. K. Hsu. Chicago: Aldine Publishing Co.

———, and Eva Hunt

1967 "Education as an Interface Institution in Rural Mexico and the American Inner City." *Midway Magazine*, VIII (2): 99-109.

———, Eva Hunt, and Roberto Weitlaner

1968 *From Parallel-nominal to Patri-nominal: Changing Cuicatec Personal Names. INAH, A*, 19: 191-223.

Icaza, Francisco de (Ed.)

1925 *Conquistadores y Pobladores de Nueva España: Diccionario Autobiográfico Sacado de los Textos Originales*. Madrid: Imprenta del Adelantado de Segovia.

Ixtlixochitl, Don Fernando de Alva

1892 "Historia Chichimeca." *Obras Históricas*, vol. 2. Mexico.

Jacobsen, Thorkild

1943 "Primitive Democracy in Ancient Mesopotamia." *Journal of Near Eastern Studies*, II, no. 3.

Jiménez Moreno, Wigberto

1953-56 "Historia Antigua de México." Class notes, mimeographed for Escuela Nacional de Antropología e Historia. Mexico.

1962 *Estudios Mixtecos. "Vocabulario en Lengua Mixteca"* by F. Fco. de Alvarado (faccimilar) with a study by Jiménez Moreno. INI and INAH.

———, and Salvador M. Higuera

1940 *Introduction, Códice de Yanhuitlan.*

Johnson, Frederick

1965 "Half-life of Radiocarbon." *Science*, 149: 1326.

——— (Ed.)

1951 *Radiocarbon Dating. SAA, M*, no. 8. Salt Lake City, Utah.

———, and Hugh M. Raup

1947 *Grassy Island. RSPFA, P*, vol. 1, no. 2.

———, and E. H. Willis

1970 "Reconciliation of Radiocarbon and Sidereal Years in Meso-American Chronology." NS12, pp. 93-104.

Jones, Richard

1831 *An Essay on the Distribution of Wealth and on the Sources of Taxation*. London.

Kalous, Milan

1970 "The Economic and Political Structure of the Benin Kingdom." *Afrika und Uebersee*, Band LIII, Heft 2. Berlin.

Keeling, C. D.

1961 "The Concentration and Isotopic Abundances of Carbon Dioxide in Rural and Marine Air." *Geochim et Cosmochin*. Acta 24: 277-298.

Kelly, Isabel, and A. Palerm

1952 *The Tajin Totonac, Part I*. Smithsonian Institution, Inst. of Soc. Anthro. Pub. no. 13.

Kidder, Alfred V.

1924 *An Introduction to the Study of Southwestern Archaeology*. New Haven.

———, Jesse D. Jennings, and Edwin M. Shook

1946 *Excavations at Kaminaljuyu, Guatemala*. CIW, Pub. 561.

Kirchhoff, Paul

1940 "Los Pueblos de la Historia Tolteca-Chichimeca: sus Migraciones y Parentesco." *RMEA*, 4: 77-104.

1947 "La Historia Tolteca-Chichimeca." *Hist. Anales de Cuautinchan*. Mexico: Antigua Robledo.

1952 "Mesoamerica: Its Geographic Limits, Ethnic Composition and Cultural Characteristics." Sol Tax (Ed.), *Heritage of Conquest*, pp. 17-30.

1954-55 "Land Tenure in Ancient Mexico." *RMEA*, 14: 351-361.

1955 "The Principles of Clanship in Human Society." *Davidson Journal of Anthropology*. University of Washington. Reprinted in M. H. Fried (Ed.), *Readings in Anthropology* (1959), vol. 2, pp. 259-270.

Klein, Herbert S.

1966 "Peasant Communities in Revolt: The Tzeltal Republic of 1712." *Pacific Historical Review*, 35: 247-263.

Kramer, Samuel Noah

1948 "New Light on the Early History of the Ancient Near East." *American Journal of Archaeology*, 52, no. 1.

Kuzara, Richard S., George R. Mead, and Keith A. Dixon

1966 "Seriation of Anthropological Data: A Computer Program for Matrix-Ordering." AA, 68: 1442-1455.

Landa, Diego de

1938 *Relación de las Cosas de Yucatán*, 7th ed. Mexico.

Lattimore, Owen

1940 *Inner Asian Frontiers of China*. New York.

Leach, E. R.

1954 *Political Systems of Highland Burma*. London School of Economics.

1959 "Hydraulic Society in Ceylon." *Past and Present*. London.

1961 *Pul Eliya*. Cambridge.

Lehmann, Walter

1905 "Les Peintures Mixteco-Zapoteques et Quelques Documents Apparentes." *Journal de Société des Americanistes de Paris*, n.s., 2: 241-280.

Lemoine Villicana, Ernesto

1954 "Ensayo de división Municipal del Estado de Oaxaca en 1950." *Yan*, vol. 2, no. 1.

Lesur, Yólotl Gonzales de

1968 *El Dios Huitzilopochtli en la Peregrinación Mexica: De Aztlan a Tula. INAH, A*, 19: 175-190.

Lewis, Herbert S.

1967 "Ethology and African Culture History." *Reconstructing African Culture History*, ed. by C. Gabel and N. Bennett. African Research Studies no. 8: 25-44. Boston: Boston University Press.

Libby, Willard F.

1955 *Radiocarbon Dating*, 2nd ed. Chicago: University of Chicago Press.

1963 "The Accuracy of Radiocarbon Dates." *Science*, 140: 278.

1965 "Natural Radiocarbon and Tritium in Retrospect and Perspect." *Proceedings of the 6th Inter. Conference on Radiocarbon and Tritium Dating*. Washington State University, June 1965. U.S. A. E. C. Conf. 650652 Chemistry (TID-4500). Washington, D.C.

1967 "History of Radiocarbon Dating." *Radioactive Dating*, p. 5. Int. Atomic Energy Agency, Vienna.

Lienzo Antonio de León, see Caso, Alfonso

Linton, Ralph

1962 "Crops, Soils and Culture in America." *The Maya and Their Neighbors*. Salt Lake City: University of Utah Press.

Lobeck, A. K.

1939 *Geomorphology: An Introduction to the Study of Landscapes*. New York: McGraw-Hill Book Co.

Longacre, Robert E.

1957 "Proto-Mixtecan." *IJAL*, 23, no. 4, part III.

1967 "Systemic Comparison and Reconstruction." *HMAI*. 5: 117-159.

Lopez, Jerónimo

16th C. Carta al Rey de . . . de algunos informes de la visita del licenciado Tello Sandoval . . . *ENE*, IV: 150-179.

Lowe, Gareth, and Alden Mason

1965 "Archaeological Survey of the Chiapas Coast, Highlands, and Upper Grijalva Basin." *HMAI*, 2: 195-236.

MacNeish, Richard S.

1958 *Preliminary Archaeological Investigations in the Sierra de Tamaulipas, Mexico. APS, T*, vol. 48, part 6.

1964*a* *Investigations in Southwest Yukon. RSPFA, P*, vol. 6, no. 2.

1964*b* "Ancient Mesoamerica Civilization." *Science*, 143 (3606): 531-537.

1967 "A Summary of the Subsistence." *The Prehistory of the Tehuacan Valley*, vol. 1, *Environment and Subsistence*, ed. by D. S. Byers. Austin: University of Texas Press.

1970 "Social Implications of Changes in Population and Settlement Pattern of the 12,000 Years of Prehistory in the Tehuacan Valley of Mexico." *Population and Economics*, ed. by P. Deprez. Winnipeg: University of Manitoba Press.

———, Antoinette Nelken-Terner, and Irmgard W. Johnson

1967 *The Prehistory of the Tehuacan Valley*, vol. 2, *Nonceramic Artifacts*. Austin: University of Texas Press.

———, and Frederick A. Peterson

1962 *The Santa Marta Rock Shelter, Ocozocoautla, Chiapas, Mexico. NWAF, P*, no. 14.

Malde, Harold E., and Cynthia Irwin-Williams

1967 "Preliminary Report on Radiocarbon Dates from the Valsequilla Area, Puebla, Mexico." Mimeographed for release by PMAAE, April 18, 1967.

Mann, Harold H., and N. V. Kanitkar

1920 *Land and Labour in a Deccan Village*. London and Bombay.

Mann, W. B., W. F. Marlow, and E. E. Hughes

1961 "The Half-life of Carbon-14." *Jour. Appl. Rad. Iso.* 11: 57-67.

Martínez Gracida (Ed.)

1883 Cuadros Sinópticos . . . de Oaxaca. Anexo 50 a la Memoria Administrativa presentada al Congreso del Mismo el 17 de Diciembre de 1883 (no pagination). Oaxaca, Mexico: Imprenta del Estado.

Martínez Ríos, Jorge

1961 *Bibliografía Antropológica y Sociológica del Estado de Oaxaca*. Instituto de Investigaciones Sociales de la Universidad Nacional, Mexico.

Marx, Karl

1853 Articles in the *New York Daily Tribune*.

1890-94 *Das Kapital*, 1. Hamburg.

1939 *Grundrisse der Kritik der Politischen Oekonomie*. Moscow.

1941 *Arkhiv Marksa i Engel'sa* 9. Moscow.

———, and Friedrich Engels

1957-68 *Karl Marx, Friedrich Engels, Werke*. Berlin.

Mejía Xesspe, M. Toribio

1942 "Acueductos y Caminos Antiguos de la Hoya del Río Grande de Nasca." *Actas y Trabajos Científicos de la Segunda Sesión del XXVII CIA* (Lima, 1939), I: 559-569.

Memorias del Estado de Oaxaca

1874-75 Imprenta del Gobierno, Oaxaca. Cuadros Estadísticos y Texto.

Mendizabal, Miguel Othon de

1929 *Influencia de la Sal en la Distribución Geográfica de Los Grupos Indígenas de México.* Mexico: Imprenta del Museo Nacional de Arqueología, Historia y Etnografía.

Metraux, Alfred

1963 *Les Incas.* Paris.

Mezquita, Francisco de la

1580 Relación de Atlatlauca y Malinaltepec. *PNE,* IV: 163-176.

Miles, S. W.

1957 *The 16th Century Pokom-Maya: A Documentary Analysis of Social Structure and Archeological Setting. APS, T,* 47: 731-781.

Mill, James

1820 *The History of British India,* 2nd ed. London.

Millon, René F.

1954 "Irrigation at Teotihuacan." *Amer. Antiq.,* 20: 177-180.

1955 "Trade, Tree Cultivation and the Development of Private Property in Land." *AA,* 57 (4): 698-712.

1957 "Irrigation Systems in the Valley of Teotihuacan." *Amer. Antiq.,* 23: 160-166.

1962 "Variations in Social Responses to the Practice of Irrigation Agriculture." *Civilizations in Desert Lands,* ed. by R. Woodbury. University of Utah Anthropological Papers, no. 62: 56-88.

1966 "Secuencia Cerámica de Teotihuacan." Teotihuacan Mapping Project. Mexico. Mimeographed.

———, Clara Hall, and May Diaz

1962 "Conflict in the Modern Teotihuacan Irrigation System." *Comparative Studies in Society and History,* 4: 494-524. The Hague.

Miranda, F. de, M. Swadesh, and R. Weitlaner

1960 "El Panorama Etnolingüístico de Oaxaca y el Itsmo. *RMEA,* 16: 137-157.

Montesquieu

1958 *Oeuvres Complêtes,* 2. Paris.

Monzón, Arturo

1949 *El Calpulli en la Organización Social de los Tenochca.* Instituto de Historia, Mexico.

Morgan, Lewis H.

1877 *Ancient Society or Researches . . . through Barbarism to Civilization.* Chicago.

Motolinía (Fray Toribio de Benevente)

1903 *Memoriales.* Documentos Históricos de México. Mexico.

1941 *Historia de los Indios de la Nueva España.* Mexico.

Murdock, George P.

1959 *Africa.* New York.

1960 "Cognatic Forms of Social Organization." *Social Structure in South East Asia,* ed. by G. P. Murdock. *VFPA,* 29.

Navarrete, Pedro de

1579 Relación de Papaloticpac y su Partido. *PNE,* IV: 88-99.

Needham, Doris, and Marjorie Davis

1946 "Cuicatec Phonology." *IJAL,* 12: 139-146.

Neely, James A.

1967 "Organización Hidráulica y Sistemas de Irrigación Prehistóricos en el Valle de Oaxaca." INAH, *Boletín* 27: 15-17. Mexico.

Nicholson, H. G.

1966 "The Problem of the Provenience of the Members of the 'Codex Borgia Group': A Summary." *Suma Antropológica en Homenaje a Roberto J. Weitlaner,* pp. 145-158.

Noguera, Eduardo

1940 "Excavations at Tehuacan," trans. by Suzannah B. Vaillant. *The Maya and Their Neighbors,* pp. 306-319. New York: Appleton.

Oakley, Kenneth Page

1964 *Frameworks for Dating Fossil Man.* Chicago: Aldine Publishing Co.

O'Gorman, Edmundo

1937 *Breve Historia de las Divisiones Territoriales: Aportación a la Historia de la Geografía de México.* Mexico: Editorial Polis.

1945 *Catálogo de Pobladores de la Nueva España.* Publicaciones del AGN.

Olson, J. C.

1958 "Some Reflections on Historical Method and Indian History." *Ethnohistory,* 5: 48-59.

Olson, Roland

1933 "Clan and Moiety in Native America." *Publications in American Archeology and Ethnology,* 351-432. University of California.

Olsson, Ingrid U. (Ed.)

1970 Nobel Symposium 12, *Radiocarbon Variations and Absolute Chronology.* Almqvist & Wiksell, Stockholm, and John Wiley and Sons, New York.

———, and I. Karlén

1963 "The Half-life of C-14 and the Problems Which are Encountered on Absolute Measurements on Beta-decaying Gases." *Radioactive Dating.* Int. Atomic Energy Agency, Vienna.

———, *et al.*

1962 "A Determination of the Half-life of C-14 with a Proportional Counter." *Arkin för Fysik* 22: 237-255.

Orozco y Berra, Manuel

1864 *Geografía de las Lenguas y Carta Etnográfica de México.* Mexico.

1938 *História de la Dominación Española en México,* 3. Mexico.

Paddock, John

1962 "Mixtec Ethnohistory and Monte Alban V." *Actas y Memorias,* XXXV ICA, Mexico. Reprinted in J.

Paddock (Ed.), *Ancient Oaxaca,* 1966, pp. 367-385.

1967 Mimeographed release of new dates determined on various Monte Alban samples. Mexico, D. F.

———, (Ed.)

1966 *Ancient Oaxaca.* Stanford: Stanford University Press.

Palerm, Angel

1954 La Distribución del Regadío en el Area Central de Mesoamerica. *Ciencias Sociales,* V: 25: 2-15; 26: 64-74.

1955 "The Agricultural Basis of Urban Civilization in Mesoamerica." *Irrigation Civilizations: A Comparative Study,* ed. by J. H. Steward. Social Science Monographs I. Pan American Union, Washington, D.C. Reprinted in Palerm and Wolf (Eds.), *La Agricultura y el Desarrollo de la Civilización en Mesoamerica,* 1961.

1967 "Agricultural Systems and Food Patterns." *HMAI,* 6: 26-52.

———, and Eric Wolf

1957 "Ecological Potential and Cultural Development in Mesoamerica." *Studies in Human Ecology.* Social Science Monographs III. Pan American Union, Washington, D.C.

——— (Eds.)

1961 *La Agricultura y el Desarrollo de la Civilización en Mesoamerica.* Pan American Union, Washington, D.C. Revista de Ciencias Sociales (second series), vol. 1 (2).

Papeles de la Nueva España (PNE), see Paso y Troncoso, Francisco del

Paredes Colin, Joaquin

1960 *El Distrito de Tehuacán.* Tipografía Comercial "Don Bosco." Mexico. (Originally published in 1921 by Tipografía "El Refugio," Tehuacan, Puebla.)

Pareto, Wilfredo

1963 *A Treatise on General Sociology.* New York.

1968 *The Rise and Fall of the Elites.* Totowa.

Pareyon, Moreno Eduardo

1960 "Exploraciones Arqueológicas en Ciudad Vieja de Quiotepec." *RMEA,* 16: 97-104.

Parsons, Lee Allen

1967 *Bilbao, Guatemala,* vol. 1. Publications in Anthropology II. Milwaukee Public Museum.

Paso y Troncoso, Francisco del (Ed.)

1905 *Papeles de la Nueva España (PNE).* 7 vols. (segunda serie). Madrid: Est. Tipográfico Sucesores de Rivadeneyra.

1912 "Division Territorial de la Nueva España en el Año 1636." *Proceedings of the ICA,* 1912: 464-483.

1939-42 *Epistolario de la Nueva España (ENE).* 16 vols. of text and 1 vol. of index. Biblioteca Histórica Mexicana de Obras Inéditas.

Peñafiel, Antonio

1885 *Nombres Geográficos de México.* Secretaría de Fomento, Mexico.

1897 Nomenclatura Geográfica de México.

———, (Ed.)

1890 *Monumentos del Arte Mexicano Antiguo.* Mexico.

1895 *Códice Fernandez Leal.* Oficina Tipográfica de la Secretaría de Fomento, Mexico.

Perez, Eutemio

1888 *Recuerdos Históricos del Episcopado Oaxaqueño.* Oaxaca, Mexico: Imprenta de San German.

Phillips, Philip, and Gordon R. Willey

1958 *Method and Theory in American Archaeology.* Chicago: University of Chicago Press.

Piña Chan, Román

1958 *Tlatilco.* 2 vols. INAH.

1960 *Mesoamerica. INAH, Memorias* no. VI.

Poleman, T. T.

1964 *The Papaloapan Project: Agricultural Development in the Mexican Tropics.* Food Research Institute. Stanford: Stanford University Press.

Ponce, Alonso

1873 Relación Breve y Verdadera de Algunas Cosas de las Muchas que Sucedieron al Padre Alonso Ponce . . . Madrid: Imprenta de la Viuda de Calero. (Note: An index by Grace Metcalfe has been published in Mexico, 1946, *Boletín Bibliográfico Antro. Amer.,* vol. VII.)

Prebish, Raul (Ed. for ECLA)

1963 *Towards a Dynamic Development Policy for Latin America.* Economic Commission for Latin America. Report to the Meeting of the United Nations in Mar del Plata, Argentina. Reprinted in P. E. Sigmund (Ed.), *The Ideologies of Developing Nations.* Praeger, University Series, pp. 368-379.

Prescott, William H.

1936 *History of the Conquest of Mexico and History of the Conquest of Peru.* New York: Modern Library.

Publicaciones del AGN

1952 El Libro de Tasaciones de los Pueblos de la Nueva España en el Siglo XVI. Mexico.

Quijada, Hernando

1579 Relación de Usila. *PNE,* IV: 45-52 (segunda serie).

Radin, Paul

1920 *The Sources and Authenticity of the History of the Ancient Mexicans.* Berkeley.

Ralph, Elizabeth K.

1959 "University of Pennsylvania Radiocarbon Dates III." *Radiocarbon* I: 45-58.

———, Henry N. Michael, and John Gruninger, Jr.

1965 "University of Pennsylvania Dates VII." *Radiocarbon* 7: 179-186.

———, and Robert Stuckenrath

1960 "Carbon 14 Measurements of Known Age Samples." *Nature,* 188: 185-187.

Ravicz, Robert S.
1965 *Organización Social de los Mixtecos.* Collección de Antropología Social No. 5. INI. Mexico.

Redfield, Robert
1928 "The Calpolli-Barrio in a Present-day Mexican Pueblo." *AA*, 30: 282-294.

Reeves, B.
1965 "Radiocarbon Dates from Mesoamerica." MS. term paper. Department of Archaeology, University of Alberta, Edmonten.

Reina, Benjamin
1967 "Milpas and Milperos: Implications for Prehistoric Times." *AA* 69 (1): 1-20.

Reischauer, Edwin O., and John K. Fairbank
1960 *East Asia: The Great Tradition.* Boston.

Relación de Atlatlauca y Malinaltepec, *see* Mezquita, Francisco de la

Relación de Coxcatlan, *see* Castañeda Leon, J. de

Relación de Cuicatlan, *see* Gallego, Juan

Relación de Cuilapa, *see* Barlow, Robert H. (Ed.)

Relación de Guautla, *see* Bernal, Ignacio

Relación de Ixtepexi, *see* Ximenes Ortiz, Juan

Relación de Juan Bautista de Pomar, *see* Garibay K., Angel María

Relación de los Obispados de Oaxaca, Tlaxcala, Michoacan y otros Lugares, *see* García Pimentel, Luis (Ed.)

Relación de Papaloticpac y su Partido, *see* Navarrete, Pedro de

Relación de los Pueblos de Tecuicuilco, Atepeq, Coquiapa, Xaltianguez
1928 *Revista Mexicana de Estudios Históricos* (Nov.-Dec.), II (6): 121-132.

Relación de Teotitlan del Camino, *see* Castaneda, Francisco de

Relación de Usila, *see* Quijada, Hernando

Reyes, Fray Antonio de los
1593 *Arte de la Lengua Mixteca.* Paris: Charencey. (1890 ed.)

Rhys-Davids, T. W.
1950 *Buddhist India*, 1st Indian ed. Susil Gupta.

Ricard, Robert
1933 *La Conquête Spirituelle du Mexique.* Université de Paris. Travaux et Memories de l'Institut d'Ethnologie, No. 20. Paris. (Note: A translation by A. M. Garibay exists in Spanish, published in 1947.)

Rickards, Constantine
1926 *The Ruins of Quiotepec, District of Cuicatlan.* ICA, XXII: 625-631. Rome.

Robertson, Donald
1958 "The Relaciones Geográficas de México." *Proceedings of the XXXIII ICA,* San José, Costa Rica.
1959 *Mexican Manuscript Painting of the Early Colonial Period: The Metropolitan School.* New Haven: Yale University Press.
1964 "Los Manuscritos Religiosos Mixtecos." *Actas y Memorias del XXXV ICA*, 1: 425-435.

Robinson, W. S.
1951 "A Method of Chronologically Ordering Archaeological Deposits." *Amer. Antiq.*, 16: 293-301.

Rosenblat, Angel
1945 *La Población Indígena de América desde 1492 hasta la Actualidad.* Buenos Aires.

Rossel Castro, Alberto
1942 "Sistema de Irrigación Antigua del Río Grande de Nasca." *Revista del Museo Nacional*, XI(2), II Semestre: 196-202. Lima.

Rouse, Irving, and José M. Cruxent
1957 "Further Comment on the Finds at El Jobo, Venezuela." *Amer. Antiq.*, 22: 412.

Roys, Ralph L.
1939 *The Titles of Ebtun.* CIW, Pub. No. 505.
1943 *The Indian Background of Colonial Yucatan.* CIW, Pub. No. 548.

Russel, J. C.
1958 *Late Ancient and Medieval Population.* Philadelphia.

Sahagun, Bernadino de
1938 *Historia General de las Cosas de Nueva España.* 3 vols. Mexico City.

Sahlins, Marshall
1958 *Social Stratification in Polynesia.* American Ethnological Society. Seattle: University of Washington Press.
1962 *Moala: Culture and Nature of a Fijian Island.* Ann Arbor, Mich.

Sanders, William T.
1956 "The Central Mexican Symbiotic Region: A Study in Prehistoric Settlement Patterns." *Prehistoric Settlement Patterns in the New World,* ed. by G. R. Willey. *VFPA*, III: 115-127.
1960-63 "Teotihuacan Valley Project: Preliminary Report." Mimeographed.
1963 "The Cultural Ecology of Nuclear Mesoamerica." *AA*, 64 (1): 34-44.
1965 "The Cultural Ecology of the Teotihuacan Valley: A Preliminary Report." Teotihuacan Valley Project. Department of Sociology and Anthropology, Pennsylvania State University. Mimeographed.

———, and Barbara Price
1968 *Mesoamerica: The Evolution of a Civilization.* New York: Random House.

Satterthwaite, Linton, and Elizabeth K. Ralph
1960 "New Radiocarbon Dates and the Maya Correlation Problem." *Amer. Antiq.*, 26: 165-184.

Sauer, Carl
1948 "Colima of New Spain in the Sixteenth Century." *IA*, 29.

Schaedel, Richard P.
1968 *On the Definitions of Civilization, Urban, City*

and Town in Prehistoric America. XXXVII ICA, *Actas y Memorias,* 1: 5-13.

Scholes, Frances V. (Paleographer)

1936 "Encomiendas de Indios," *Boletín del AGN,* VII (3): 352-361.

Seele, Enno

1969 "Galerías Filtrantes en el Área de Acatzingo-Tepeaca, Estado de Puebla." INAH, *Boletín* 35: 3-8.

Selden Roll, see Burland and Kutscher (Eds.)

Seler, Edward

1906 *Einige fein bemalte alte Thongefasse der Dr. Sologuren'schen sammlungaus Nochistlan und Cuicatlan un Staate Oaxaca.* ICA, XV (2): 391-403. Quebec.

Seler-Sachs, Caecilie

1912 *Die reliefcherben von Cuicatlan und Teotitlan del Camino.* ICA, XVIII: 206-215. London.

Service, Elman R.

1962 *Primitive Social Organization: An Evolutionary Perspective.* New York: Random House.

Simeon, Remi

1885 *Dictionnaire de la Langue Nahuatl.* Paris.

Simpson, Leslie Byrd

1937 *The Ejido: Mexico's Way Out.* Chapel Hill: University of North Carolina Press.

1952 "Exploitation of Land in Central Mexico in the Sixteenth Century." *IA,* 36.

Sjoberg, Gideon

1952 "Folk and Feudal Societies." *American Journal of Sociology,* 58: 231-239.

Smith, Adam

1937 *An Inquiry into the Nature and Causes of the Wealth of Nations.* New York.

Smith, C. Earle, Jr.

1965*a* "Agriculture, Tehuacan Valley." *Fieldiana: Botany,* 31: 49-100. Chicago Natural History Museum.

1965*b* "Flora, Tehuacan Valley." *Fieldiana: Botany,* 31: 101-142. Chicago Natural History Museum.

1967 "Plant Remains." *The Prehistory of the Tehuacan Valley,* vol. 1, *Environment and Subsistence,* ed. by D. S. Byers. Austin: University of Texas Press.

Smith, Robert E.

1958 "The Place of Fine Orange Pottery in Mesoamerican Archaeology." *Amer. Antiq.,* 24: 151-160.

———, and James C. Gifford

1965 "Pottery of the Maya Lowlands." *HMAI,* 2: 498-534.

Southworth, C. H.

1931 "Gila River Survey Report," vol. 1, Supplemental Exhibits. Manuscript. Pueblo Grande Museum, Phoenix, Ariz.

Spaulding, Albert C.

1958 "The Significance of Differences Between Radiocarbon Dates." *Amer. Antiq.,* 23: 309-311.

Spencer, J. E., and G. A. Hale

1961 "The Origin, Nature, and Distribution of Agricultural Terracing." *Pacific Viewpoint,* 2: 1-40. Wellington.

Spores, Ronald

1964 "The Genealogy of Tlazultepec: A Sixteenth-century Mixtec Manuscript." *SJA,* 20: 15-31.

1965 "The Zapotec and Mixtec at Spanish Contact." *HMAI,* 3: 962-987.

1967 *The Mixtec Kings and Their People.* Norman: University of Oklahoma Press.

Starr, Frederick

1899 *The Indians of Southern Mexico: An Ethnographic Album.* Chicago.

1900 *Notes Upon the Ethnography of Southern Mexico.* Author's Edition. Chicago.

1902 "The Physical Character of the Indians of Southern Mexico." *Decennial Publications,* IV. Separata of Materials of the University of Chicago.

1908 *In Indian Mexico — A Narrative of Travel and Labor.* Chicago.

Steward, Julian H.

1949 "Cultural Causality and Law: A Trial Formulation of the Development of Early Civilizations." *AA,* 51.

1953 "Evolution and Process." *Anthropology Today,* ed. by A. L. Kroeber. Chicago: University of Chicago Press.

———, (Ed.)

1955 *Irrigation Civilization: A Comparative Study.* Social Science Monographs no. 1. Pan American Union, Washington, D.C.

Straus, William L., and Charles B. Hunt

1962 "Age of Zinanthropus." *Science,* 136: 293-295.

Strong, Wm. Duncan

1953 "Historical Approach in Anthropology." *Anthropology Today,* ed. by A. L. Kroeber. Chicago: University of Chicago Press.

Stuiver, Minze

1961 "Variations in Radiocarbon Concentration and Sunspot Activity." *Jour. Geophys. Res.,* 66: 273-276.

1970 "Long-term C14 Variations." NS 12, pp. 197-213.

———, and Hans E. Suess

1966 "On the Relationship between Radiocarbon Dates and True Sample Ages." *Radiocarbon* 8: 534-540.

Suess, Hans E.

1961 "Secular Changes in the Concentration of Atmospheric Radiocarbon." *Proc. Nuclear Science Series,* Report No. 33. National Academy of Science, Pub. 845, pp. 90-95. Washington, D. C.

1965 "Bristlecone-pine Calibration of the Radiocarbon Time-scale 4100 b.c. to 1500 b.c." *Proc. 6th Int. Conf. Radiocarbon and Tritium Dating,* pp. 415-428. Pullman, Wash.

1970 "Bristlecone-pine Calibration of the Radiocarbon Time-scale 5200 b. c. to the Present." NS12, pp. 303-311.

Suma de Visitas de los Pueblos por Orden Alfabético

1905 MS2800 Biblioteca Nacional de Madrid. *PNE*, I (segunda serie). Paso y Troncoso, Ed.

Swartz, Marc, Victor W. Turner, and Arthur Tuden

1966 *Political Anthropology.* Chicago: Aldine Publishing Co.

Taracena, Angel

1941 *Apuntes Históricos de Oaxaca: Desde los Tiempos Precortesianos hasta la Época Actual.* Oaxaca, Mexico.

Tauber, H.

1970 "The Scandinavian Varve Chronology and C14 Dating." NS12, pp. 173-196.

Taylor, Walter W.

1956 "Some Implications of the Carbon-14 Dates from a Cave in Coahuila." *Texas Archaeological Society Bulletin,* 27: 215-234.

Tello, Julio C.

1930 *Andean Civilization: Some Problems of Peruvian Archaeology.* Proceedings of the XXIII ICA.

Tinoco, Nicolas (Notario Público)

1699 "Sobre Geografía a Lingüística en Algunas Partes de Oaxaca, 3 enero de 1699." In Heinrich Berlin, *Fragmentos Desconocidos del Códice de Yanhuitlán y otras Investigaciones Históricas.* (Mexico, 1947).

Tolstoy, Paul, and André Guenétte

1965 "Le Placement de Tlatilco dans le Cadre du Préclassique du Bassin de Mexico." *Journal de la Société des Américanistes,* 54: 47-91.

Torquemada, Juan de

1723 *Monarquía Indiana.* 3 vols. Madrid. (3rd ed., 1943, Mexico City.)

Tozzer, Alfred M.

1941 *Landa's Relación de las Cosas de Yucatán. PMAAE,* R 18.

Troll, Carl

1963 "Qanat-Bewässerung in der Alten und Neuen Welt: Ein Kulturgeographisches und Kulturgeschichtliches Problem." *Mitteilungen der Österreichischen Geographischen Gesellschaft,* Festschrift Hans Bobek, Teil II (Schriftleitung, Konrad Wiche), Band 105 (Heft III): 313-330.

Turney-High, Harry Holbert

1949 *Primitive War.* Columbia, S. C.

Twenhofel, W. H.

1950 *Principles of Sedimentation.* New York: McGraw-Hill Book Co.

Vansina, Jan

1965 *Oral Tradition.* London.

1967 "The Use of Oral Tradition in African Culture History." *Reconstructing African Culture History,* ed. by C. Gabel and N. Bennett. African Research Studies no. 8, pp. 55-82. Boston: Boston University Press.

Velasco, A. L.

1891 *Geografía y Estadística del Estado de Oaxaca.* Mexico.

Villaseñor y Sanches, Joseph Antonio de

1748 *Teatro Americano: Descripción General de los Reynos y Provincias de Nueva España.* Imprenta de la Viuda D. Bernardo de Hogal. Photocopy by the Editora Nacional, S. A., Mexico. (1952 ed.)

Walton, Alan, Milton A. Trautman, and James P. Friend

1961 "Isotopes, Inc. Radiocarbon Measurements." *Radiocarbon* 3: 47-59.

Wang Yü ch'üan

1937 "The Rise of the Land Tax and the Fall of Dynasties." *Pacific Affairs.*

Weber, Max

1923 *Wirtschaftsgeschichte.* Munich and Leipzig.

1947 *The Theory of Social and Economic Organization,* ed. with an introduction by Talcott Parsons. New York: The Free Press.

Weitlaner, Roberto

1961 *Datos Diagnósticos para la Ethnohistoria del Norte de Oaxaca.* INAH, Dirección de Investigaciones Antropológicas, Pub. 6. Mexico.

1969 "The Cuicatec." *HMAI,* 7: 434-447.

———, and Carlo Antonio Castro G.

1954 "Mayultianguis y Tlacoatzintepec." *Papeles de la Chinantla,* I. INAH, Serie Científica No. 3.

———, and William Holland

1960 "Use of Pre-Hispanic Knives." *Amer. Antiq.,* 25.

Willey, Gordon R.

1953 *Prehistoric Settlement Patterns in the Viru Valley, Peru. BAE,P,* 155.

1966 "Maya Lowlands Ceramics: A Report from the 1965 Guatemala City Conference." Mimeographed. Harvard University, Cambridge.

———, (Ed.)

1956 *Prehistoric Settlement Patterns in the New World. VFPA,* no. 23

———, G. F. Ekholm, and René F. Millon

1964 "The Patterns of Farming Life and Civilization." *HMAI,* 1: 446-498.

Willis, E. H., H. Tauber, and K. O. Münnich

1960 "Variations in the Atmospheric Radiocarbon Concentration Over the Past 1300 Years." *Radiocarbon* 2: 1-4.

Wittfogel, Karl August

1924 *Geschichte der buergerlichen Gesellschaft.* Vienna.

1926 *Das erwachende China.* Vienna.

1927 "Probleme der chinesischen Wirtschaftsgeschichte." *Archiv fuer Sozialwissenschaft und Sozialpolitik.*

1929 "Geopolitik, geographischer Materialismus und Marxismus." *Unter dem Banner des Marxismus.* 3.

1931*a* "Hegel ueber China." *Unter dem Banner des Marxismus,* 5.

1931*b* *Wirtschaft und Gesellschaft Chinas.* Leipzig.

1932 "Die natuerlichen Ursachen der Wirtschaftsgeschichte." *Archiv fuer Sozialwissenschaft und Sozialpolitik,* 67.

1935 "The Foundations and Stages of Chinese Economic History." *Zeitschrift fuer Sozialforschung,* 4.

1938 "Die Theorie der orientalischen Gesellschaft." *Zeitschrift fuer Sozialforschung,* 7.

1940 "Oriental Society." Manuscript.

1955 "Developmental Aspects of Hydraulic Societies." *Irrigation Civilization: A Comparative Study,* ed. by J. Steward. Social Science Monographs No. 1. Pan American Union, Washington, D.C.

1956 "The Hydraulic Civilizations." *Man's Role in Changing the Face of the Earth,* ed. by William L. Thomas, Jr. Wenner-Gren Foundation. Chicago.

1957*a* "Chinese Society: A Historical Survey." *Journal of Asian Studies.*

1957*b* *Oriental Despotism: A Comparative Study of Total Power.* New Haven: Yale University Press.

1958 "Class Structure and Total Power in Oriental Despotism." *Contemporary China.*

1960 "The Marxist View of Russian Society and Revolution," *World Politics,* no. 4.

1962 "The Marxist View of China." *The China Quarterly,* July-Sept.

1971 "Irrigation Policy in Spain and Spanish America." In *Essays on the Modernization of Underdeveloped Societies.* 2 vols. University of Bombay.

———, AND FÊNG CHIA-SHÊNG

1949 *History of Chinese Society, Liao. APS, T,* 36.

———, AND ESTHER S. GOLDFRANK

1943 "Some Aspects of Pueblo Mythology and Society." *Journal of American Folklore,* Jan.-March.

WOLF, ERIC

1959 *Sons of the Shaking Earth.* Chicago: University of Chicago Press.

1966 *Peasants.* Englewood Cliffs, N. J.: Prentice-Hall.

———, AND ANGEL PALERM

1955 "Irrigation in the Old Acolhua Domain, Mexico." *SJA,* 11: 265-281.

WOODBURY, RICHARD B.

1960 "The Hohokam Canals at Pueblo Grande, Arizona." *Amer. Antiq.,* 26: 267-270.

1961 *Prehistoric Agriculture at Point of Pines, Arizona. SAA, M* no. 17.

———, AND AUBREY S. TRIK

1953 *The Ruins of Zaculeu, Guatemala.* 2 vols. United Fruit Company, Boston.

WORMINGTON, H. M.

1957 *Ancient Man in North America,* 4th ed. Denver Museum of Natural History, Popular Series No. 4.

WULFF, H. E.

1968 "The Qanats of Iran." *Scientific American,* 218: 94-105.

XIMÉNEZ ORTIZ, JUAN

1579 Relación de Iztepexi. *PNE,* IV: 9-23 (segunda serie).

ZARATE, BARTOLOMÉ DE

1544 Relación de . . . vecino y regidor de Mexico sobre historia y gobierno de Nueva España. *ENE,* pp. 130-148.

ZAVALA, SILVIO, AND M. CASTELO

1939 *Fuentes para la Historia del Trabajo en Nueva España.* Fondo de Cultura Económica, Mexico.

ZEUNER, FRIEDRICH E.

1946 *Dating the Past: An Introduction to Geochronology.* London: Methuen.

ZIMMERMAN, JOSEF D.

1966 *Irrigation.* New York: John Wiley & Sons.

INDEX

Abdel-Malek, A., 59

Abejas Cave (Tc 307), 9; stratigraphy, 18–19; El Riego types, 18; composition of zones, 19, 20; contemporaneity of zones, 19, 21, 22; dates on zones, 19, 20, 48; sample dates from, 20, 24; El Riego occupations, 18–19, 20; Coxcatlan occupations, 19, 21, 22; Abejas occupation, 22, 24; Palo Blanco occupation, 31, 96; radiocarbon dates, 20; artifacts, 22, 24; and Purron Dam complex, 82, 92, 94–95; Zone H, 18, 19; Zone G, 18, 19, 20; Zone F, 18, 19, 20; Zone E, 19; Zone D^2, 19, 20; Zone D^1, 19, 20; Zone D, 21; Zone C, 21, 22; Zone B^1, 20; Zone B, 20, 22, 24; Zone A, 31, 48, 96

Abejas phase: radiocarbon years and sidereal time, 5, 6; chronology, 22–24; estimated time span, 22, 24, 41; relationships, 41; subsistence, 116; settlement pattern, 150; artifacts, 22, 24

  Sample dates, 33; from Tc 50, 17; from Tc 307, 20; from Tc 272, 23; from Tc 254-1, 23; correlated, 33

Acatzingo-Tepeaca region, Puebla, 148

Acontepeque (Acontepec, Oaxaca), 174

Adams, R. M., 61, 162, 165, 227, 229

Adan, E., 256

African despotism, 60

African hydraulic tribes, 60, 66, 71

African migration, 239

African oral traditions, 214

Agave, 168

Agriculture: beginnings of, 25, 54; *bolsa*, 96; *barbecho*, 125, 151; *milpa*, 125; Purron Dam area, 83, 99, 150–152; Xiquila flood plain, 109, 111–112; terracing, 113–125 *passim*, 133, 151–152, 181; hillside systems, 113–116, 125; valley systems, 113, 116–125; Tehuacan Valley, 125–126; saline soils, 133, 135; Spanish cultivation, 194–195; management in Latin America, 227. *See also* Cuicatec irrigation, Cuicatec agriculture, Irrigation, Fruit, Sugar cane, and other cultivated crops.

Agua Azul spring, 103

Agua de la Catrina, Oaxaca, 213

Agua del Mixteca, Puebla, 121

Aguila, Marcos de, 256

Aguilar phase (Panuco), 45, 46

Ahuizotl (Aztec ruler), 209

Ajalpan clay pits, 9, 25

Ajalpan site (Ts 204), 9, 25, 26; stratigraphy, 26, 30; artifacts, 26; contemporaneity of zones, 26, 27; dates on zones, 26, 27, 41, 43; samples, 27; trade sherds, 43; early Ajalpan occupations, 25–27; late Ajalpan occupations, 27–28; late Santa Maria occupation, 30; radiocarbon dates, 27; Zone H, 26, 27, 41; Zone G, 26–27, 41; Zone G^1, 27, 41; Zone F, 27, 43; Zone F^1, 27, 43; Zone B, 30; Zone A, 30

Ajalpan burial pit (Ts 204C), 27, 28

Ajalpan site (Ts 204D), 26; contemporaneity, 26, 27; occupation, 26, 27; pottery types, 26; trade sherds, 43; Zone E, 26, 27, 43; Zone B, 26; Zone A, 26

Ajalpan phase: radiocarbon years and sidereal time, 5; chronology, 25–28; estimated time span, 25, 26, 28; seriation, 25; transition date, 25, 26; settlement pattern, 150

  Sample dates: from Tc 254-1, 23; from Tc 272, 23; from Ts 204 and 204C, 27; from Ts 368e, 29

  Early subphase: artifacts, 41; dates, 41–42, 34; estimated time span, 42; pottery types, 42; relationships, 42

  Late subphase: components, 42; dates, 34, 42; estimated time span, 27, 42; pottery types and ceramic traits, 42–43; relationships, 42–43; artifacts, 26

Ajuereado phase: radiocarbon years and sidereal time, 5; chronology, 16–18; sample dates from Tc 50, 17; dates, correlated, 33; estimated time span, 16–18, 39; early occupation, 16, 18, 37–39; late occupation, 16, 18, 39; components, 37, 39; climate, 37–39; artifacts, 16, 37, 39; faunal remains, 37, 39; relationships, 39

Alavez, Esteban de, Melchor de, 225

Almoloyas settlements, 208–212 *passim*

Alpizagua (Santiago Dominguillo, Oaxaca), 171, 173, 175

Altar de Sacrificios (Petén, Guatemala): relationships, 44, 47, 51

Altepexi, Puebla, 131, 137, 148

Altepexi scarp, 128, 132

The Alvarado (1593), 165

Amaranth, 150

Amatle phase (Guatemala): relationships, 52

Amecameca, 214, 217, 218, 239

Amer, I., 59

Antelope remains, 37

Apantle(i), 127, 139, 148, 188, 213. *See also* Canals, Cuicatec canals

Apoala, 215, 217

Aqueducts, *see* Cuicatec irrigation, Irrigation, Xiquila Aqueduct

Aragon Coronado, F., 249

Arana Osnays, E., 214

Architecture: monumental, 99; Cuicatec, 165, 212

Archives, Cuicatlan and San Andrés Teotilalpan, 229, 252

Archivo General de la Nación, 164, 184, 249–252; *Ramos*, 256, 257

Arenal phase (Guatemala highlands): dates, 36

Arevalo phase (Guatemala highlands): dates, 36, 47; relationships, 47

Armillas, P., 68, 162, 165, 235

Arroyo de Atexcala, 113

Arroyo Lencho Diego, 83, 125; drainage, 83, 92; irrigation, 83, 93–97 *passim*, 99; floods, 87–88, 96; rainfall, 90, 99; occupation, 92, 94–97, 99; agriculture, 95

Artifacts: seriation, 7, 9, 12, 15; computer analysis of, 13–14;

Santa Marta cave, 40; in the Desert Tradition, 40. *See also* names of artifacts and under Tehuacan phases and sites
Aryan military nobility, 73, 74
"Asiatic" concept, Marx, 62–63
"Asiatic" typology, Wittfogel, 66
Asin, J. O., 149
Atlatlahuca (AGN *Ramos*), 250
Atlatlauca, 171, 173; identified, 174; glyphs, 172, 174, 185; subject settlements, 174–175, 202; irrigation, 195, 197, 198, 233; population, 197, 198; Spanish tribute, 198; settlement pattern, 200–202 *passim*; cacique residence, 201, 204; slaves, 205; social organization, 205; saint's name, 207; warfare, 208, 209; trade, 212; archaeological site, 213; political organization, 220; cacique succession, 222, 224, 257; Spanish control, 230; AGN *Ramos*, 250, 251; relación, 221, 225, 227, 236, 253
Atoto phase (Valley of Mexico): dates, 35, 45, 46; relationships, 45, 46; diagnostic pottery and figurine types, 46
Atoyac river basin, 245
Atzompa springs, 128
Aurora phase (Guatemala highlands): dates, 36, 37, 48, 50; relationships, 48; trade wares, 50
Avaslaslac, cacique, 257
Avocado: remains, 93; and irrigation, 94, 95; cultivation, 150, 195
Awls, 40
Axusco, Puebla, 121
Ayampuc phase (Guatemala highlands), 51
Ayotla phase, Tlapacoya (Valley of Mexico), 43
Aztec Mexico: and the hydraulic approach, 61; hydraulic despotism, 64, 78; "loose" hydraulic society, 66, 68, 69; flood control, 69; military organization, 71; power structure, 73–74, 76; salt trade, 74; meso-hydraulic pattern, 76. *See also* Aztecs
Aztecs: and Cuicatec cacicazgos, 183, 208, 209, 233, 234, 242, 254; land rights, 203, 204–205; tribute, 197–198, 209, 212, 241; descent groups, 206; *calpul*, 205, 206, 238, 240; *calpulli*, 227; *Tlatoani*, 220, 221, 238; political organization, 220, 242; succession, 222; agricultural economy, 227, 242; elite intermarriage, 241; ethnic group, 243. *See also* Aztec Mexico

Babylonia, 72
Bakry, M. P., 81
Bali irrigation society, 191–192
Balsas region irrigation, 235
Bandelier, A. E., 71
"Barbarism", 64, 78
Barra phase (Guatemala-Chiapas coast), 42
Barranca de Caulipan, 39
Barranca Grande, 114
Barranca Manzanillo, 115
Bartolome, Don, 256
Basham, A. L., 73
Batana, 71
Beans, 195
Benin kingdom, 60
Bennyhoff, J. A., and Heizer, R. F., 43
Bernal, I., 165
Bifaces, 21, 40
Bilboa site (Guatemala coast), 52
Binford, L. R., 239
Blades, 21, 24, 25, 26, 31, 39, 40
Blankets, 40
Blasquez L., L., 142, 147
Boc phase (Peten, Guatemala), 52
Bomba phase, Tlapacoya (Valley of Mexico), 43
Bones, extinct animal, 24, 33, 37, 39
Bonilla Pacheco, C., 252
Bowls, 21, 22, 40, 42, 48, 52
Brunet, J., 128, 137, 139, 142
Brush, C. F., 41
Buiza, Alonso de, 169
Burgoa, F. de, 162, 164, 208
Burins, 16, 39
Buttinger, J., 59–60
Burials: Tc 272, 21; Tc 50, 31; at Tlatilco, 43; early Palo Blanco, 47. *See also* Ajalpan burial pit (Ts 204C)
Burma highlands, 228

Cacalotepec, Oaxaca: relocated population, 171, 211, 254; identified, 179, 180, 223; founding of, 218; and cacique succession claims, 198, 219, 222–223, 224, 225, 254–255, 255–256. *See also* San Lorenzo Yepaltepec
Cacapetlan, *see* Xayacatlan
Calnek, E., 162, 227
"Calpisques", 212
Caminaa, Canchuchu, 254
Camino Real, 169
Campeche, 51
Cañada de Cuicatlan: ecology, 166, 168, 195, 231; settlement, 168, 202, 231; irrigation agriculture, 167–168, 184–185, 188, 193–197 *passim*, 232, 240; Cuicatlan waterworks, 188–189; population density, 197–198, 233; political domination, 206, 230, 233; Spanish settlers, 230. *See also* Cuicatec irrigation
Canals: Purron Dam complex, 90, 91; Tr 447, 100; Xiquila Aqueduct, 107; modern Tehuacan, 130–133, 136–137, 150; Cuicatec, 188–189, 196, 227, 232; Cuicatlan, 188–189, 232. *See also* Fossil canals, Purron Dam complex, Xiquila Aqueduct, Irrigation, Cuicatec irrigation
Canoa, 101, 188
Carbon-14 half-life, 4, 5, 6, 15
Carrasco, P., 60, 68, 220
Carvajal, Don Ysauro, 144, 146, 148
Casas Grandes, Chihuahua, 151
Caso, A., 165, 205, 215, 244
Catholic saints, and Cuicatec religion, 206–207
Cauac phase, Tikal (Petén, Guatemala), 35, 47
Caucasus corridor, 232
Cehpech phase (Yucatan), 52
Celts, 26
Cempoala phases (Veracruz), 51, 52, 53
Ceramic period, 24
Ceramics, *see* Figurine types, Pottery, Pottery types, Vessels and vessel forms, Wares
Ceremonial centers, 200, 202
Cerro Chichiltepec, 83
Cerro de las Cruces, 177
Cerro Galeana, 177
Cerro de la Mesa, 142
Cerro de las Mesas phases (southern Veracruz), 47, 50, 53
Cerro San Andrés, 135
Cerro Zopilote, 177
Chagga hydraulic tribe, 66, 71
Chain well systems, 139–149, 152–153; map, 138; El Huizache,

137; El Riego, 137, 143; functions, 140–141; open, 141, 146; closed, 141; windlass, 141, 145–146; physiographic aspects, 141–142; slope and size, 142–143; excavation, 141–142, 144–147, 148; flow, 142, 147; vertical shafts, 143–144, 148; costs, 144; maintenance, 147; chronology, 147–148; origin of, 147–149, 214; associated prehistoric sites, 148; in South America, 148; No. 395, 140; No. 397, 139, 144, 145; No. 398, 144; No. 401, 148; No. 407, 140; No. 409, 148; No. 425, 142; No. 427, 146, 148; No. 442, 148; No. 448, 148; No. 464, 143; No. 478, 142

Chalchihuites, 188, 200, 212

Chalchihuitl, 213

Chalchihuitlicue, Cuicatec goddess, 188, 207, 227, 237

Chalma, Puebla, 131, 132, 142

Chamberlain, R. S., 220

Channels, *see* Canals, Fossil canals

Chantico, god, 237

Chapulapa, Oaxaca, 171, 177, 179, 213, 228

Chiapa VIII, 50

Chiapa de Corzo, Cotorra (Chiapas), 34, 48, 50

Chiapas: relationships, 40, 42, 44, 46–47, 48, 50–53 *passim;* trade wares, 28, 44; Tohil Plumbate, 51; chronology, 44

Chicanel phase, Uaxactun (Petén, Guatemala), 47

Chichimec migrations, 182, 211, 213, 214, 218

Chicomecotal, 256

Chicozapote orchards, 168, 195, 196, 212

Chicozapotes (San Pedro Chicozapotes, Oaxaca), 171, 176, 177, 185

Chila phase (Panuco), 45, 46

Chilac (San Gabriel Chilacatla, Puebla), 131, 135, 136, 142, 148, 154, 245

Chilac site (Ts 381e, w), 18, 22, 24

Chilchiltengo, 174

Childe, V. Gordon, 61

Chili: remains, 150; cultivation, 168, 195

Chimalpain, 214

Chimaltecutli, Don Martin, 255

China: hydraulic approach to, 60, 62, 65, 66; hydraulic development, 60, 65, 66; "loose" hydraulic society, 66, 68–69; flood control, 69; "feudal" trend, 72; salt production, 74, 79; irrigation networks, 246

Chinampas, 64, 69, 243

Chinantec: language group, 166, 175, 200, 232; geo-ecological area, 166–169 *passim;* agriculture, 185, 213; warfare, 209, 212; traders, 212; settlement, 232

Chinantla, 175, 184

Chiquihuitlan, Oaxaca, 183

Chocho-Popoloca, 166, 211, 213, 214, 232

Cholula, Puebla, 53, 218

Choppers, 26, 39, 40

Chorro de Agua, Oaxaca, 228, 229

Chronology, 6; and radiocarbon dating, 6–7, 15; Mesoamerican, 4–7; Tehuacan, 7–32, 82; Purron Dam, 82, 92–94; Xiquila Aqueduct, 109; field systems, 116, 124, 125; fossil canals, 135–139; chain well systems, 147–148

Chronometric methods, 4. *See also* Radiocarbon dating

Chuen phase, Tikal (Petén, Guatemala), 35, 47

Chukumuk site (Guatemala highlands), 47

Chupandilla remains, 94

Chulavista, Puebla, 120

Cimi period, Tikal (Petén, Guatemala), 36, 48

Ciruela remains, 94

Citlaltecutli, 217, 218, 223, 224, 254

Classic Period, 211 ,212, 213, 237, 245

Classic phases, and late Palo Blanco, 50–51

Cline, H., 162, 164

Coahuila, 39, 41

Coapa (Coapam de Guerrero), 179, 256

Coapan, Puebla, 131, 132

Coatecotle, 255

Coatepec site (Ts 368e, w), 9, 25; excavation and stratigraphy, 26, 30; deposition of zones, 26; composition, 28, 29, 30; dates on zones, 28, 29, 46; contemporaneity, 29; Ajalpan occupations, 26, 28; Santa Maria occupations, 28–30; Venta Salada occupation, 32; zone distribution, 30; sherd samples, 29; figurines, 45, 46; diagnostic types, 45, 46; related sherds, 46; related trade ware, 47; ceramics, 28, 29; sample dates from, 29, 30, 44; Zone K, 26; Zone K^1, 28, 29; Zone J, 26, 28, 29; Zone I, 28, 29, 45; Zone H, 28, 29, 44, 45; Zone G, 28, 29, 45; Zone F, 29, 44, 45; Zone E, 29, 45; Zone D, 29, 45, 46; Zone C^2, 29; Zone C^1, 29; Zone C, 46, 47; Zone B^1, 46; Zone B, 29, 30, 46, 47

Coatepec wares, 26, 28, 45, 46

Cochineal, 200, 212

Codex Ayautla, 219, 252

Codex Baranda, 215

Codex Boturini, 74

Codex Cuicatlan-Quiotepec, *see* Codex Quiotepec-Cuicatlan

Codex Fernandez Leal, 185, 186, 188, 199, 208, 210, 217

Codex Martinez Gracida, *see* Codex Quiotepec-Cuicatlan

Codex Mendocino (Mendoza), 175, 185, 186, 215

Codex Porfirio Diaz, 185, 186, 188, 199, 210, 217, 227

Codex Quiotepec-Cuicatlan (Codex Martinez Gracida), 182, 199, 200, 208, 218, 219, 252–253, 255, 256–257

Codex Selden, 214, 215

Codex Tlacoatzintepec, 210

Codices, Cuicatec, *see* Cuicatec codices

Codices, Chinantec, 210

Codices, Mixtec, 215

Coe, M., 243

Coffee, 195

Coixtlahuaca, Oaxaca, 176, 209; pottery, 212–213

Colhua-Mexica region, 163. *See also* Aztec Mexico, Aztecs

Colijn, A., 3

Colima, 239, 244

Colonia San Martin, Puebla, 102

Comales, 49

Comaltianguisco, *see* Tecomaltianguisco

Complex A (southern Veracruz), 44

Computer seriation, 3, 13–14

Concepción Papalo, 164, 179, 207, 230

Conchas phases 1, 2 (Guatemala coast): dates, 35, 45; relationships, 45

Conquistadores, 225

Cooly, M. E., 81

Copan stela, 52

Cook, S. F., 244

Coquiapa, 174–175

Cortez, H., 255, 256, 257

Cosahuico remains, 94

Cotahuixtla, Oaxaca, 175

Cotahuixtla, San Francisco, 251

Cotahuixtla-Nacaltepec, 252

Cotorra phases (Chiapas): dates on, 34, 42; relationships, 42, 43

Cotton: remains and irrigation, 93, 95; cultivation, 150, 195; trade, 205, 212

Covers, pot, 48, 49

Coxcatlan Cave (Tc 50), 9, 16; radiocardon dates, 14; date distribution, 16–18; excavation and stratigraphy, 16, 19; composition of zones, 16, 19, 20, 21, 22, 31; contemporaneity of zones, 18, 19, 21, 22, 24; zone distribution, 16, 22; dates on zones, 16, 18, 19, 20, 21, 24, 30, 31, 32, 40, 47, 51; sample dates from, 17, 19, 20, 21–22, 24, 30, 31, 32; and Ajuereado phase, 37; Ajuereado occupations, 16, 18; El Riego occupations, 18–19, 19–20, 39; Coxcatlan occupation, 20–22; Abejas occupation, 22–24; Santa Maria occupation, 24, 30; Palo Blanco occupations, 31; Venta Salada occupations, 31, 32; diagnostic traits, 16, 18; artifact types, 18, 19, 21, 22, 24, 30, 31, 39, 40; time marker, 21; sequence transition, 24; pottery types, 30, 31, 51, 94; abandonment of, 24, 25; cloth sample from, 31; fauna extinction and climatic change, 39; and Purron Dam, 94; Zone XXVIII, 16, 18, 36, 37; Zone XXVII, 16, 37; Zone XXVI, 16, 37; Zone XXV, 16, 17, 37; Zone XXIV, 17, 37; Zone XXIII, 16, 17, 37; Zone XXII, 17, 18, 19, 39; Zone XXI, 17, 18; Zone XX, 17, 19; Zone XIX, 18; Zone XVIII, 17, 18, 19; Zone XVII, 17, 18, 19; Zone XVI, 17, 19, 20; Zone XV, 17, 19, 20, 21, 40; Zone XIV, 16, 19, 21, 40; Zone XIII, 17, 20, 21, 40; Zone XII, 20, 21; Zone XI, 17, 20, 21, 22; Zone X, 17, 22, 24; Zone IX, 17, 22, 24; Zone VIII, 17, 22, 24; Zone VII, 17, 24, 30; Zone VI, 17, 31, 47, 94; Zone V, 17, 31, 94; Zone IV, 17, 31; Zone III, 17, 32, 51, 52; Zone II, 17, 32, 51

Coxcatlan phase: radiocarbon years and sidereal time, 5, 6; chronology, 20–22; estimated time span, 21, 22, 40, 41; correlated dates, 33; sample dates, 17, 23; subsistence, 20, 40, 116, 150; artifacts, 21, 40; point types, 40–41; relationships, 40–41

Coxcatlan Ruin (Tr 62), 32, 94

Coxcatlan Terrace (Ts 51), 9; artifacts, 19, 22; El Riego occupation, 19; Abejas occupation, 22, 24; Palo Blanco occupation, 31; contemporaneity of zones, 19, 22, 24; Zone D–E, 19; Zone C, 22, 24; Zone B, 31; Zone A, 31

Coxcatlan trade, 212, 213

Coyol remains, 94

Coyotlatelco (Valley of Mexico), 52

Coyula, Oaxaca (Cuyulapa): identified, 178; land use and settlement, 201–202, 202–203, 211; archaeological site, 213; cacique succession, 223, 254

Cozahuatl springs, 128, 136, 139

Cross-dating, 32, 53–54

Cuadros phase (Guatemala coast), 28, 34, 42, 43

Cuanalan phase (Valley of Mexico), 46

Cuetlahuixtla (San Francisco Cotahuixtla, Oaxaca), 175

Cuetlaxtecutli, 255, 256

Cueva Blanca phase (Mitla, Oaxaca), 33, 40–41

Cueva de la Zona, Nuevo Leon, 33, 41, 52

Cuhuantecuhtli, 255

Cuicatec agriculture, 185, 231–232; and political leadership, 163; in the Cañada, 168, 194–195, 196, 232, 240; highlands, 177, 233, 240; highland-canyon contrast, 240; infield/outfield, 177, 232; "jugo", 185; "tonamil", 185; Spanish introduced crops, 194–195; surplus, 197, 235; production today, 197; orchards 189, 201, 204, 212; "nopaleras", 200; and settlement pattern, 202; early, 218; administration, 227, 242; "going to plant", 228. *See also* Cuicatec irrigation

Cuicatec archaeology: documentation, 165; house-sites, 169, 186, 200, 201, 231; Xocoyoltepec site, 176, 177; and Papalo mythological reservoir, 178; Cuicatlan, 185, 186, 196, 200; and evidences of outside contact, 212–214

Cuicatec barrios, 171. *See also* Cuicatec subject settlements

Cuicatec cabeceras, 169, 171, 173, 203, 232, 237. *See also* Cuicatec settlements

Cuicatec cacicazgos (states), 231; identification of, 169–184; term derivation, 171; relations between, 205–208; economic symbiosis, 205–206, 208, 212, 234; political organization, 218–221; highland-canyon contrast, 233. *See also* Cuicatec state system

Cuicatec caciques: residence and jurisdiction, 169, 204, 224, 225, 238; Spanish titles, 171, 173, 218–219, 221; succession claims, 198, 219, 222–223, 224, 225, 254–255, 255–256; *propiedad*, 199, 226; rights, privileges, responsibilities, 203–205, 208, 219, 224, 225–226, 230, 235, 238; reigning dates, 218; Spanish *tasaciones*, 219, 224, 225–226; of Yepaltepec, 219; of Atlatlauca, 220; *posesión* ceremonies, 224–225; religious functions, 226–227, 229; political powers, 193, 211, 225–227; Aztec support of, 229; Spanish support of and domination, 229–230; genealogies, 164, 221–225, 254–257. *See also* Cuicatec elite, Cuicatec genealogies

Cuicatec calendar, 217, 218

Cuicatec Cañada, *see* Cañada de Cuicatlan

Cuicatec canals, 188–189, 196, 227, 232. *See also* Cuicatec irrigation

Cuicatec ceremonial centers, 200, 207, 227, 237

Cuicatec codices, 235; and Cuicatec waterworks, 164, 185–188, 193, 199; and mythology of common descent, 206; water wars recorded, 210; year notation, 217; and political rights, 224. *See also* names of codices

Cuicatec-Colima comparisons, 244

Cuicatec commoners, 201, 203, 206; social differentiation, 220–221, 238–239, 241; and land redistribution, 226, 237; specialists, 239; group identity, 240. *See also* Cuicatec ***tequitlatos***

Cuicatec communication routes, 168–169

Cuicatec curers, 221

Cuicatec *ditonidona*, 218, 219, 221, 223, 254, 256

Cuicatec *Dyille Ebe*, 219, 221, 223

Cuicatec ecology, 165, 166–169, 231, 239–240

Cuicatec economic symbiosis, 205–206, 208, 212, 234

Cuicatec elite: and succession, 165, 171, 221–225, 228, 235, 238, 240; and water control, 192, 193, 241, 245; households, 201, 204, 220; descent, 206, 208, 212, 214, 217–219, 222, 231, 235, 238; intermarriage, 206, 212, 217, 223–224, 238, 241; origins, 214–218; highland-canyon contrast, 220; political powers, 223–230, 236, 239, 240; present-day, 231; and political fusion, 234; office lands, 235; roles, 236, 240; and the Cuicatec state system, 241. *See also* Cuicatec caciques, Cuicatec genealogies

Cuicatec estancias, 171, 206. *See also* Cuicatec subject settlements

Cuicatec ethnography, 164, 165

Cuicatec feudal states, 234

Cuicatec field work, 163, 165–166

Cuicatec fiestas, 206–207, 220

Cuicatec genealogies: Papalo, 206; Monjaras, 208; "telescoping",

217, 218; chart, 220; and succession rules, 221–225. *See also* Cuicatec elite descent
Cuicatec geography, 165, 166–169
Cuicatec haciendas, 190
Cuicatec highland-canyon contrasts, 220, 232, 233, 240, 244
Cuicatec hydraulic pattern, 76
Cuicatec hydrography, 166
Cuicatec Indian revolts, 230–231, 256
Cuicatec irrigation, 163, 184–200, 211–213, 231–232, 234; in the Cañada, 167–168, 184–185, 188, 193–197 *passim*; highland, 167–168, 177, 178, 185, 197; archaeological, 185, 186, 213; aqueducts, 188; canals, 188–189, 196, 227; evidence in codices, 185–188, 193; and centralization of authority, 190–191; and population density, 197–198; and warfare, 210–212; and water source conflicts, 240; fragmented pattern of, 243–244. *See also* Cuicatec agriculture, Cuicatec water rituals, Cuicatec water sources, Cuicatec water wars
Cuicatec irrigation society, 163–164, 234, 235; documentation, 164–166, 184; control of water sources, 167, 171, 195, 198; land ownership and water distribution, 171, 189–191, 193, 198, 199–200; and centralization of authority, 190–194 *passim*; "loose" hydraulic, 242–243. *See also* Cuicatec state system
Cuicatec kinship and descent, 206, 218–219, 222, 231, 236, 238, 239
Cuicatec land use, 200–202
Cuicatec land redistribution, 203, 225–227, 235, 237
Cuicatec land ownership and water rights, 189–190, 193, 199–200, 202–205, 208, 234, 235
Cuicatec language, 173; documentation, 165; and Mixtec language, 214, 216, 217
Cuicatec language group, 166, 167, 200, 223–224, 231–233
Cuicatec *macehuales*, 203, 204, 221, 224–225
Cuicatec *mayeques*, 203, 204, 205, 220
Cuicatec migration and colonization, 171–173, 202, 211, 214, 218, 228, 239, 241, 242
Cuicatec military, 211, 220, 226, 227, 229, 236, 241, 242
Cuicatec-Mixtec relations, 169, 233; warfare, 208–212, 233; archaeological contact, 212–214; language, 214, 216, 217; mythological common origin, 214–218, 239; elite, 217. *See also* Mixtec
Cuicatec *moradores*, 203
Cuicatec municipal system, 231
Cuicatec *municipios*, free, 169, 177, 180, 203, 223
Cuicatec mythology: Papalo lagoon legend, 178; Chiquihuitlan, 183; gods and goddesses, 188, 200, 206–207, 237; and elite common descent, 206, 214–219, 239
Cuicatec northward relations, 168–169, 212–214, 230–231
Cuicatec *nyandi*, 173, 204, 205, 221
Cuicatec *parcialidad*, 171. *See also* Cuicatec subject settlements
Cuicatec peasantry, *see* Cuicatec commoners
Cuicatec pilgrimages, 212
Cuicatec political balance, 235
Cuicatec political fission (schismogenesis), 173, 223, 228–229, 231, 232, 234, 240, 241, 242. *See also* Cuicatec *municipios,* free
Cuicatec political organization, 218–221, 233–234. *See also* Cuicatec state system
Cuicatec population, 197–198, 232, 233, 241
Cuicatec pottery, 165, 212, 213
Cuicatec priesthood (*sacerdotes*), 220, 221, 226, 236–237. *See also* Cuicatec religion
Cuicatec *principales*, 219
Cuicatec *provincias,* 171
Cuicatec *pueblos,* 171. *See also* Cuicatec subject settlements
Cuicatec region (Cuicatlan District), 166, 171, 211, 231, 233; climate, 166, 231–232; agriculture, 167–168; northeasterly movement, 183; outside relationships, 168–169, 234, 239–240, 241; and the Tehuacan Valley, 212, 213, 214, 230–231; Spanish domination, 229–230; present-day, 230–231
Cuicatec relaciones, 164, 184. *See also* Relación de Atlatlauca, etc.
Cuicatec relations, outside, 208–214
Cuicatec religion, 206–207, 220, 226–227, 229, 237, 240. *See also* Cuicatec mythology, Cuicatec priesthood
Cuicatec ritual and ceremonialism, 206–207
Cuicatec salt trade and production, 75, 205, 212, 213, 227–228
Cuicatec *señores naturales*, 220
Cuicatec *señorío,* 171, 236. *See also* Cuicatec cacicazgos, Cuicatec state system
Cuicatec settlement pattern, 112, 200–202, 232, 237
Cuicatec settlements, 163, 169–184; map, 170; identified, 173–184; political relationships, 169; historical stability, 169, 232, 237; names, 169–170, 206–207; sources of identification, 169–171; house-sites, 169, 186, 200, 201; location and water sources, 167, 185, 202, 211–212, 231, 232; reference sources, 184; mountain region, 177, 206, 230, 231, 233; Cañada, 168, 202, 231; defensive location, 232; codex glyphs, 172–184 *passim,* 185–188; religious celebrations, 206–207, 220; and Tehuacan Valley, 230–231. *See also* Cuicatec settlement pattern, Cuicatec subject settlements, Cuicatlan, and names of settlements
Cuicatec slaves, 205, 221, 239, 241
Cuicatec social classes, 218–221, 237–239. *See also* Cuicatec commoners, Cuicatec elite, Cuicatec kinship and descent
Cuicatec social stratification, 201, 205, 220, 226, 237
Cuicatec society, 163. *See also* Cuicatec irrigation society
Cuicatec sources of documentation, 164–166
Cuicatec specializations, 221
Cuicatec state dynasties, origin of, 214–218, 239
Cuicatec state system, 211–212, 218–221, 233–234, 237–238, 239–240, 241, 242. *See also* Cuicatec cacicazgos
Cuicatec subject settlements, 169–173 *passim*; of Atlatlauca, 174–175; of Papalo, 178–179; of Tepeucila, 180–181; of Quiotepec, 182–183; and headtowns, 200, 202. *See also* Cuicatec settlement pattern
Cuicatec succession rules, 164, 165, 221–225
Cuicatec *sujetos,* 171. *See also* Cuicatec subject settlements
Cuicatec *tecpan, see* Cuicatec cabecera (headtown)
Cuicatec *tecuhtli,* 219, 220, 236, 238
Cuicatec-Tehuacan Valley contact, 212, 213, 214, 230–231
Cuicatec temple festivities, 206–207, 220
Cuicatec temple lands, 204, 205, 220
Cuicatec *tequios,* 193, 205
Cuicatec *tequitlatos,* 173, 193, 203, 204–205, 220–221, 239
Cuicatec *terrasguero,* 203
Cuicatec trade, 205, 212, 213, 227
Cuicatec tribute, 197–198, 209–210, 212, 241
Cuicatec tribute grants (*tasaciones*), 219, 224, 225–226
Cuicatec *tumultos,* 228–229

Cuicatec warfare, 206, 208–212, 225, 233, 234, 236, 242. *See also* Cuicatec military, Cuicatec water wars
Cuicatec water control, *see* Cuicatec irrigation, Cuicatec irrigation society
Cuicatec water judges, 189, 192
Cuicatec water rituals, 185, 207, 227
Cuicatec water sources, 166–168, 171, 199–200, 232; control of, 167, 171, 195, 198, 231, 233; and population centers, 167, 185, 202, 211–212, 231, 232; Cuicatlan, 193–198 *passim*
Cuicatec water wars, 185, 187, 210–212, 228; codex illus., 187, 209, 210; Yepaltepec, 171, 193, 198, 199, 228, 232; in Spanish documents, 199, 200; modern *(tumultos)*, 228–229
Cuicatlan, 165, 166, 169; identified, 171, 173, 175–177, 207, 215; glyphs, 176, 186, 214, 215–217; archaeological survey, 165, 185, 186, 194, 196, 200–201, 213; canals, 188–189, 193–194; land ownership and water distribution, 189-190; water control, 190–191, 193; leadership roles, 194; irrigation agriculture, 194–197; water supply and population, 196, 197; and Guendulain, 197; population densities, 197–198; tributes, 197–198; and Papalo water rights, 198, 233; land use and settlement pattern, 200–201, 202; trade, 205, 212; and the Guevara manuscript, 208; Aztec tributary, 209; relación, 215, 219, 230, 253, 255, 256; *Guetrabaco,* 215; cacique inter-marriage, 224; archives, 229, 252; Spanish dominated, 230; mythological capital, 234; AGN *Ramos,* 249, 250, 251, 252; caciques' genealogy, 256. *See also* Cañada de Cuicatlan
Cuicatlan District, 166, 171, 175, 176, 177, 179, 184. *See also* Cuicatec region
Cuicatlan *provincia,* 171
Cuicuilco, Valley of Mexico, 43, 45, 48
Cullancan, Don Miguel, 223, 254
Cullulapa, *see* Coyula, Oaxaca
Cultivation, *see* Agriculture, Irrigation
Cuyamecalco, Oaxaca, 228, 232, 242
Cuyulapa, *see* Coyula, Oaxaca

Dahlgren de Jordan, B., 162, 244
Dams: Tehuacan Valley, 99, 100–102, 107–108, 133, 150, 151, 243; Papalo legendary, 178; Cuicatlan, 188. *See also* Irrigation, Cuicatec irrigation, Purron Dam complex, Site Tr 447, Site Tr 446
Davalos Hurtado, E., 162
Davidson, E. S., 81
Decoration, *see* Wares
Desert Tradition, 40
Despotism, and irrigation, 246. *See also* Oriental despotism
de Vries, H., 5, 6
Diakonoff, I. M., 61
Dikes, Aztec, 69
Dili phase (Chiapas), 35, 44
Disks, 22, 24, 49
Dixon, K. A., 3
Dog bones, 24
Dominguillo, Oaxaca, 171, 173, 175
Dozier, E. P., 60
Durkheim, E., 241, 246
"Dynastic cycle", 66, 79

Early Classic time markers, 49
Early Formative period, 25
Early Period, Phase I (Chakan), 37
Eb phase, Tikal (Petén, Guatemala), 35, 45
Egypt: hydraulic approach to, 59, 62; non-"Oriental" trend, 72; trade, 74; ruling "caste", 78
Ejidatarios, 189
Ejido system, 152, 203
El Arbolillo (Valley of Mexico), 45
El Coyul, 180
El Riego irrigation systems, 137–139
El Riego Cave (Tc 35) travertine deposits, 137. *See also* El Riego East (Tc 35e), El Riego West (Tc 35w)
El Riego East (Tc 35e), 9; occupations, 31, 32; artifacts, 49; pottery, 52; Zone F, 31; Zone E, 31; Zone D, 31, 49; Zone C, 31, 52; Zone B, 31, 52; Zone A, 31, 32
El Riego West (Tc 35w), 9; Coxcatlan materials, 20, 21; contemporaneity of zones, 19, 21; Ajuereado occupation, 16, 18; El Riego occupation, 19; Palo Blanco occupation, 31; Venta Salada occupations, 31–32; artifacts, 16, 18, 21; age of, 21; and the Ajuereado phase, 37; Zone 6, 16, 18, 37; Zone 5, 18, 19, 21; Zone 4, 21, 31; Zone 3, 31–32; Zone 2, 31–32; Zone I, 32
El Riego chain well system (no. 464), 143
El Riego phase: radiocarbon years and sidereal time, 5, 6; chronology, 18; estimated time span, 18, 19, 20, 39, 40; components, 39, 40; artifacts, 18, 19, 39, 40; point types, 40; Desert Tradition, 40; relationships, 39–40
  Sample dates, 33; from Tc 50, 17; from Tc 272, 23; from Tc 307, 20; correlated, 33
El Riego springs, 128
El Huizache chain well system, 137
El Zapotillo, 190
Elite, *see* Ruling class, Cuicatec elite
Eloxochitlan, Puebla, 125
End-scrapers, 22, 26, 39, 40
Epistolario de la Nueva España, 164
Erasmus, C. J., 98, 101, 112
Escalera phase (Chiapas), 44
Eslabones phase (Tamaulipas), 37, 50
Esperanza phase (Guatemala highlands), 36, 37, 50
Espinosa, Dona Marta de, 257
Etla District, 171, 174, 175
Etla valley irrigation, 213
Exnab phase (Petén, Guatemala), 52
Eyman, C. E., 3

Farming, *see* Agriculture
Fauna, extinct, 24, 33, 37, 39
Feet types, 48, 49
Fernea, R. A., 234
Field borders, 100, 131, 151–152
Field houses, 97, 101, 120, 121
Field patterns, 131
Field systems, 113–127, 151–152; hillside, 113–116, 151–152; valley, 113, 116–125; air photos, 122–124; chronology, 116, 124, 125; labor in construction, 125–126; productivity, 125
Figurines, 28, 42, 45–49 *passim,* 52
Flacco phase (Tamaulipas), 33, 41
Flakers, 40
Flannery, K. V., 39, 40, 245
Flint chip, 39
Floods, 88, 96; control, 69; cultivation, 133, 135
Florescent phase (Yucatan), 51
Foggaras, 139

Fonseca, Don Domingo de, 175
Formative period, irrigation in, 83, 136, 150–152, 213, 245
Fossil canals, 127–139, 152, 245; map, 126; deposition, 127–129; origins and pattern, 129–130; notched, 130, 133; drainage, grade, and flow, 131, 132, 133; and terracing, 133; and associated sites, 135; sherds, 135–136; cleaning, 136–137; chronology, 135–139; at El Riego 137–139
Francesca phase (Chiapas), 35, 44, 46–47
Frightful Cave (Coahuila), 39, 41
Fruit: remains, 93, 94, 95; cultivation, 102, 168, 190, 195, 212

Gaitan, Juan, 230, 256
Galerías, 137–139
Gav, J. A., 208
Geertz, C., 191, 192
Gibson, C., 125, 135, 171, 173, 223, 244
Gil Huerta, 136, 139, 148, 154
Glick, T., 233
Gods, *see* Cuicatec mythology
Goldfrank, E. S., 68
Gonzales, Yolotl, 162
Gouges, 40
Gourds, 116
Gravers, 39
Gray, R. F., 60, 71
Guadalupe phase (Valley of Oaxaca), 44, 245
Guanacaste phase (Chiapas), 35, 46, 47
Guapa, *see* Coapa
Guatemala: dates, 28, 50; coast relationships, 42, 53, 45, 50, 52, 53; highlands relationships, 45, 47, 48, 50, 51, 52
Guautla (Huautla, Oaxaca), 175, 208, 209, 233, 236, 257
Güendulain (Valerio Trujano, Oaxaca), 168, 188, 190, 197; AGN *Ramos*, 252
Guerrero: relationships, 41, 42; dams, 108
Guetrabaco, 215
Guevara: family members, 208, 209, 256; manuscript, 208, 255, 256
Guilá Naquitz Cave (Mitla, Oaxaca), 33, 39–40
Guilds, 72–73
Gulf coast relationships, 51
Guzman, caciques, 256

Hacienda San Andrés, 131, 137
Hamadan, Iran, 141, 149
Hammer stones, 40
Hathaway, W. H., 3
Haury, E., 60
Hawaiian Islands, 71, 74
Hegel, G. W. F., 77
Hernandez, Don Domingo, 198, 219, 222–225 *passim*, 254, 255–256
Hernandez, Dona Maria, 256
Hernandez, Don Miguel, 219, 255, 256
Hidalgo, 40, 211
Hidalgo Fuentelsaz, M. G., 142
Hierve el Agua, 136
Hillside field systems (terracing), 113–116, 125, 151–152; chronology, 116, 125
Hilltop sites, 96, 97, 135; Tr 296, 109, 110, 111
Hodge, F. W., 66
Hohokam civilization, 60, 66
Hopkins, E. W., 73
Horcasitas P., F., 82
Horcones phase (Chiapas), 35, 46, 47, 48
Horticulture, Lencho Diego canyon, 83. *See also* Agriculture
Hotel Iberia well, 141
House sites: Xiquila, 109–110; Cuicatec, 169, 186, 200, 201, 231
Huajuapan de Leon, Oaxaca, 169
Huasteca, 53
Huautla, Oaxaca, *see* Guautla
Hueyatlaco, Valsequillo, Puebla, 39
Huitzapa, 174
Huitzilopochtli, military god, 237
Huitziltengo (La Laguna, Oaxaca), 174
Huiztepec, 179, 223, 255
Hunt, E., 69, 75, 76, 82
Hunt, R. C., 162–163, 165
Hydraulic patterns, 75–76
Hydraulic societies: theory, 59–61; Tehuacan, 61, 76; ecology, 62; agro-managerial function, 62, 69, 73, 74; and despotism, 62; in Mesoamerica, 63–64, 66–69, 72, 73–75, 76, 242–246; Asiatic, 63; bureaucracy, 64–65; diversities in, 65–66; "loose", 66, 68, 242–243; protective waterworks, 69; institutional expansion, 69–72; military rule, 70–74, 79; compact, 71; spatial expansion, 72; and "societal divides", 72–73; "feudal" trends in, 72; merchant guilds in, 72–73; and military aristocracies, 73; trade regulations, 74; manpower, 75; monumental style, 75; population density, 75, 79–80; Mixtec, 243–244; role of irrigation in, 245–246. *See also* Irrigation societies, Oriental despotism
Hydro-electric plants, 140–141
Hydrography, Cuicatec, 166
Hydrology, Tehuacan Valley, 127–129, 142, 148

Ibahku (Cuicatlan), 215
Iglesia phase (Valley of Mexico), 34, 35, 45
Ik phase, Tikal (Petén, Guatemala), 36, 50
Incan society, 60, 64, 66, 68, 74, 222
Incense burners, 49, 53
India, hydraulic society, 66, 72–73
Indostan, hydraulic society, 62
Indus Valley civilizations, 74
Infiernillo complex (Tamaulipas), 33, 40
Instituto de Antropología (INAH), 164
Instituto de Investigaciones Históricas (IIH), 164
IPCCS document, 164–165, 184, 217, 218, 229, 253, 254–256
Irrigation, 6, 79, 83, 163; Lencho Diego canyon, 83, 93–97 *passim*, 99, 150–152; Rio Xiquila, 102, 103, 108, 109, 111–112; Tilapa canyon, 99; Tecorral canyon, 100, 101; Tr 446, 102; Tr 447, 100, 101; Zapotitlan Valley, 102; and plant remains, 93–96; Tehuacan Valley, 125–126; diversion dams, 107–108, 133, 150, 151; spring-fed canals, 127–130; flooding, 133–135; chain wells, 140–141; and centralization of authority, 190–193; barranca, 193; use of major rivers, 195–196; well and bucket, 141, 145–146, 195, 245; abandonment after conquest, 235; and conflict, 240; and despotism, 246; and urbanization, 246; Mesoamerican, 163, 192, 211–212, 214, 242–246. *See also* Agriculture, Cuicatec irrigation, Cuicatec agriculture, Cuicatlan, Water control, Purron Dam complex, Site Tr 446, Site Tr 447, Xiquila Aqueduct, Dams, Canals, Fossil canals, Chain well systems
Irrigation societies: and centralization of authority, 190–194; and

conflict, 190–194, 211, 240; Japan, 67, 191, 243; Bali, 191–192; Pul Iliya, 194; role of irrigation in, 242–246. *See also* Cuicatec irrigation society, Hydraulic societies
Iscoatula (San Andrés Papalo, Oaxaca), 181
Isle de Sacrificios (Veracruz), 51, 52, 53
Isleta irrigation, 79
Isotopes, Inc., 14, 15
Istmo phase (Chiapas), 36, 48
Itecotli, 256
Ixcatec language group, 232
Ixcatlan, Oaxaca, 182, 253
Ixtapan phase (Valley of Mexico), 39
Ixtapan mammoth, 33, 39
Ixtepexi, 208, 209, 210–211, 212
Ixtlan District, 171, 175
Iztactepexi (Ixtaltepec, Oaxaca), 174

Jacobsen, T., 73
Jade specimens, Teotihuacan, 49
Japan: irrigation, 67, 243; water cooperatives, 191
Jayacatlan, *see* Xayacatlan
Jimenez, D. Arturo, 162
Jimenez Z., G., 253
Jiquipilas phase (Chiapas), 48, 50
Jocotipac, 242
Johnson, Dorothy M., 3
Johnson, F., 3, 162
Justo phase (Tlapacoya), 43
Juxtlahuaca, 244

Kalous, M., 60
Kaminaljuyu, 50
Karezes, 139
Keeling, C. D., 7
Kelly, I., 162, 244
Kidder, A. W., 66
Kirchhoff, P., 68
Kramer, N., 73
Kroeber, A. L., 66

La Laguna, Oaxaca, 174
La Perra phase (Tamaulipas), 33, 41
La Raya, Oaxaca, 182–183
La Venta (Veracruz), 34–35, 42, 44, 46
Laguna, Teotihuacan, 50
Lagunita phase (Guatemala coast), 50
Land redistribution, 203. *See also* Cuicatec land redistribution
Las Canoas site (Ts 367), 9, 25; contemporaneity, 29; composition of zones, 29–30; sample dates from, 30, 44; Santa Maria occupations, 29–30; Venta Salada occupations, 32; diagnostic artifact types, 45; Zone D^2, 29, 30, 45; Zone D^1, 29, 30, 45; Zone C, 29, 30, 44; Zone B, 32; Zone A, 32
Las Charcas phase (Guatemala highlands), 35, 45, 47
Las Flores phase (Panuco/Tampico), 52
Las Huertas, Puebla, 102, 103, 107
Late Formative period, 211, 213
Leach, E. R., 59, 228
Lencho Diego canyon, *see* Arroyo Lencho Diego
Lerma phase (Sierra de Tamaulipas), 33, 39
Lewis, G. R., 81
Lewis, H. S., 239
Lex data, lex rogata, 61, 77
Libby, W. F., 4
Lienzo Antonio de Leon, 215
Llano de la Taza, 131, 132
Llano Tiopa, 211, 223, 254
Llano Verde (llanguey), 201
Llegada (San Francisco la Raya, Oaxaca), 192–183
Loma Larga, 115
Longacre, R. E., 216, 217
Lopez, Don Sebastian, 256
Los Angeles phase (Tamaulipas), 52, 53
Los Cues, AGN *Ramos*, 251. *See also* Tecolotlan (Los Cues)
Los Obos-Cuicatlan, AGN *Ramos*, 252
Los Reyes (Los Santos Reyes Papalo), 169, 177, 179, 213; identified, 180; mythology, 180, 207; Papalo conflict, 180, 200, 251; AGN *Ramos*, 251, 252
Los Reyes Metzuntla, 120
Los Santos Reyes Papalo, *see* Los Reyes

MacNeish, R. S., 3, 163, 165, 213, 231, 245
Macro-hydraulic patterns, 75–76
Madrid, qanat systems, 141, 149
Maize: early remains, 21, 22, 95; water requirements, 99; Tecorral canyon, 116; Valley of Mexico, 125; Coxcatlan phase, 150; Cuicatec cultivation and production, 168, 189, 195–198 *passim;* Cuicatec trade in, 205
Majadas phase (Guatemala highlands), 35, 45, 47
Malde, H. E., and Irwin-Williams, C., 39
Maldonado, M., 257
Malinaltepec, Oaxaca, 171, 173, 175, 212, 232
Mamey cultivation, 195
Mammoth remains, 33, 39
Mamom phase (Uaxactun), 44–45, 47
Mango cultivation, 168, 194–195
Manik phase, Tikal (Petén, Guatemala), 36, 50
Manos, 19, 21, 25, 26, 31, 40
Manpower: in hydraulic societies, 75; Purron Dam, 97–99; Tr 447, 101; Xiquila Aqueduct, 112
Maravillas phase (Chiapas), 52
Marin, C. Martinez, 208
Martinez Gracida, 165, 208; codex, *see* Codex Quiotepec-Cuicatlan
Marx, K., hydraulic views, 61, 62; classical elements, 62, 77–78; "Asiatic" concept, 62–63, 65, 78; on New World "Village Indians", 64, 78; on Egyptian ruling "caste", 78
Masapa, 180
Matzanel phases, Uaxactun (Petén, Guatemala), 48
Maya waterworks, 66
Mayauel, Cuicatec god, 237
Mayo village, manpower, 98
Mazapan phase (Valley of Mexico), 51, 52
Mazatec: language group, 166, 173, 182, 200, 212, 232; territory, 182, 183, 213, 231; irrigation, 213; and the Cuicatec, 213; elite, 219, 223, 241; migrations, 242. *See also* Quiotepec
Mazatlan, 211
McPherron, A., 165
Medel, J., 254
Mejor es Algo phase (Guatemala coast), 50
Melanesian complex, 60
Mendizabal, 227
Mendoza, Don Antonio de, 254, 255

Mendoza, Don Alonzo de, 256
Mendoza, M., 162
Mequitongo, 82
Merchant guilds, 72–73
Mesoamerican archaeology, 236
Mesoamerican ethnohistory, 243, 244
Mesoamerican hydraulic societies, 60–61; early writings on, 63–64; Wittfogel on, 66–68; "loose 2", 68–69, 72; flood control, 69; power structure, 73–75; hydraulic patterns, 76
Mesoamerican state systems: role of irrigation in, 163, 242–246; and ethnohistorical analyses, 165, 243, 244, 245; and archaeological evidence, 81, 165, 236, 243
Meso-hydraulic patterns, 75, 76
Mesopotamia, 61, 73, 237, 246
Metalpilis, Teotihuacan, 49
Metates, 25, 40, 49
Metepec phase (Valley of Mexico), 36, 48, 49, 50
Mexica, *see* Aztec
Mexico: waterworks, 67, 71; government water control, 234, 235
Mexico, Valley of: chronology, 44, 50; trade wares, 45, 46; relationships, 39, 43, 45–53 *passim;* and irrigation, 163, 199, 211, 246; succesion rules, 223; urban centers, 237
Mezquita, Martin de la, 225
Miahuatlan, Puebla, 130, 131, 132, 142
Miccaotli phase (Valley of Mexico), 48, 50
Micro-hydraulic patterns, 75, 76
Migrations: African, 214; Chichimec, 211, 214, 218; Mixtec, 214, 218, 239, 242; and cultural evolution, 239. *See also* Cuicatec migration and colonization
Military aristocracies, 70–74 *passim,* 79. *See also* Cuicatec military
Mill, J., 64
Milling stones, 26, 40
Millon, R., 191, 192, 234
Milpas, 125
Mineral waters, Tehuacan, 128, 140
Mirador-Soyatenco, 50
Miraflores phase (Guatemala highlands), 36, 45, 47
Mitla, Oaxaca, 39–40, 136
Mixquic water conflicts, 199, 234
Mixtec: language group, 166, 173, 200, 214, 216, 217, 232; ecological area, 166–169 *passim*, 213; descent, 204, 206, 214–218, 239; warfare, 208–212 *passim*, 233; migration and colonization, 214, 218, 239, 242; pottery tradition, 212, 213; mythology, 215; cacique succesion, 223, 224, 241; "community kingdoms", 238; hydraulic society, 243–244; relaciones, 244. *See also* Cuicatec-Mixtec relations
Mixteca-Alta, 102, 176, 235
Mixtec-Trique dialect, 216
Moctezuma II, 208, 209, 236, 256, 257
Mogote del Tablar, Puebla, 120
Monjaras family, 208, 254–257 *passim*
Monte Alban I–V (Oaxaca), 99, 245; dates, 35–37, 46, 47, 49, 51, 53, 213; wares, 46, 51; relationships, 46–49 *passim*, 52, 53
Montes, Don Pedro, 142, 144, 148
Montesquieu, 62, 64, 78
Monuments, 50
Moreno, J., 162, 217
Morgan, L. H., 64, 78
Mortars, 16, 40
Moser, C. L., 81
Motul phase (Yucatan), 37, 50
Mullers, 26, 40
Muluk phase, Tikal (Petén, Guatemala), 36, 48
Murdock, G. P., 60

Nacaltepec (Santiago Nacaltepec, Oaxaca), 175
Nanacaltepec, AGN *Ramos,* 252
Nahuatl, 214, 232
Narvaez troops, 225
Nasca, Peru, 148
Nativitas, Puebla, 131
Nebaj site (Guatemala highlands), 51
Necoxtla, Puebla, 130, 131, 132, 135, 148
Neely, J. A., 81, 154
Neely, Mary Ann, 82
Nequametl, 211
Newberry Library, 162, 164
Nicholson, H. B., 50
Nogales phase (Sierra de Tamaulipas), 41
Noguera, E., 49
Nomadic hunting, 54
Nonoalca-Chichimeca, *see* Chichimec migrations
Nopaleras, 200
Notasinguey, 255
Nuer, 238
Nuevo Leon, 41, 52

Oaxaca, 225; dates correlated, 28, 50; pottery types, 28; relationships, 39–40, 42, 44, 46, 47, 49, 50, 51
Oaxaca, Valley of: Mixtec invasion of, 181; Cuicatec potsherds related, 213; irrigation, 213, 245, 246; urban centers, 237
Obispados de Oaxaca, relación, 164, 184
Obos, 190
Obsidian, Teotihuacan, 49
Ocampo phase (Tamaulipas), 33, 41
Ocos phase (Guatemala coast), 42
Ojitlan, 175
Ojo de Agua spring, 103
Ollas, 48, 49
Olmec chronology, 44
Omemiquiztli, 255
Oral traditions, 165, 214
Orchards, *see* Fruit cultivation
Oriental despotism: Egypt, 59, 62; Tibet, 60; and African despotism, 60; ecological interpretation, 62; agro-managerial interpretation, 62; and Marx's "Asiatic" concept, 62–63; and Mesoamerica, 63–64, 66–69, 72, 73–75, 76; diversities in, 65; China, 60, 62, 65–66, 68–69, 72; "dynastic cycle" in, 66, 79; and non-"Oriental" trends, 72–73; and Mesoamerican irrigation societies, 243, 244
Oriental Society, theory of, 65–66. *See also* Hydraulic. societies, Oriental despotism
Ornaments, Teotihuacan, 49
Osorio, S., 253
Otatitlan, 212
Otomie descent groups, 206

Paddock, J., 49
Paint palettes, 24
Palerm, A., 125, 150, 163, 244
Palmillas phase (Tamaulipas), 37, 50

Palo Blanco phase: radiocarbon years and sidereal time, 5, 6; chronology, 31; sample dates, 17, 23; salt trade, 74

Early subphase: artifacts, 31; dates, 36, 47, 48; components, 47, 48; figurines, 47, 48; pottery types, 47, 48; occupation span, 48; relationships, 47–48; and Purron Dam, 94, 96; field systems in Tecorral canyon, 115, 116; and irrigation agriculture, 150–152

Late subphase: artifacts, 31; estimated time span, 31, 48, 50, 51; dates, 36–37, 50; components, 48; dated samples, 48; potsherds, 48; relationships, 48–51; time markers, 49; and Classic phases, 50–51; and Purron Dam complex, 94, 96–97, 101, 102; and Xiquila Aqueduct, 109–110, 111; field systems in Tecorral canyon, 114, 116, 121, 122, 124, 125; fossil canal system, 135–139; chain wells, 148; and irrigation agriculture, 151–152

Palomitas, Dona Maria Dyille Ebe, 254

Pamplona (Guatemala highlands), 52

Panoyan, 214

Panuco: relationships, 42, 43, 45, 50, 52; wares, 45, 46

Panuco period, 53; IV, 49

Papalo, 168, 171, 173, 179, 205; identified, 177–178; glyphs, 178, 185; lagoon legend, 178; butterfly glyph legend, 178; subject settlements, 178–179, 202; irrigation, 178; agriculture, 185, 200; population, 197–198; tribute, 197–198, 209; water rights, 198; land use and settlement patterns, 200, 201, 202; land tenure, 202–203; kinship, 206; trade, 205, 212; archaeological sites, 213; relación, 217, 253; migration from Amecameca, 214, 239; elite descent, 217–218; genealogies and succession, 206, 222–223; cacique inter-marriage, 206, 224; date of foundation, 218; Spanish dominated, 230; land settlements with Tepeucila, 230; AGN *Ramos*, 249, 251; rulers, 219, 220, 254–257 *passim*

Papalo-Cuicatlan water arrangements, 233

Papalo-Los Reyes conflict, 180, 200, 251

Papalo-Quiotepec conflict, 171, 193, 198, 199, 210, 211, 223, 225, 233, 254

Papalo-Tepeucila dynasty, 206, 217–218, 254

Papalo-Teutila *provincia*, 171

Papalo wife of Xicotenantli, 211

Papaloapan Basin, 166, 212

Papaloapan Commission, 81, 83, 99, 101, 103, 105, 108, 112, 253

Papaloticpac, 249, 250–251

Papalotiepa, 249

Papeles de la Nueva España, 164; caciques' genealogy, 254, 255, 256

Paradis, 43

Parcialidad, 171

Paredon phase (Chiapas), 37, 52

Paredon-Moctezuma site (Chiapas), 51

Pareto, W., 65, 78

Pareyon, M. E., 165

Paso y Troncoso, F. del, 162

Patlachique phase (Valley of Mexico), 36, 48

Pavon phase (Panuco), 42

Pebble hammers, 39, 40

Pebble mullers, 40

Pebble polishers, 24

Pecos River complex, 41

Peru: and the hydraulic approach, 60; and "Asiatic" despotism, 64, 66

Pestles, 22, 24, 26, 40

Petén, Guatemala: relationships, 44–45, 47, 48, 50, 52; dates, 50; wares, 50; pottery, 51

Petlanco, Puebla, 135

Pica, Chile, 148

Picutla (Santa Maria Papalo, Oaxaca), 169, 177, 180

Piedra Parada phase (Chiapas), 36, 48

Piedra Blanca (Peña Blanca), 179, 201

Pima Indians, manpower, 98, 112

Pithaya phase (Panuco), 48, 50

Plants: Desert Tradition, 40; remains, 93, 94, 116; domestications, new, and irrigation, 245–246; cultivation, *see* names of plants

Plum (*obos*) cultivation, 168, 195, 212

Pochteca, 75

Points: El Riego and related, 40; Coxcatlan and related, 40–41; Desert Tradition, 40; early Venta Salada, 52; related Santa Marta, 40; late Ajuereado correlated, 39

Types: Plainview, 16; Trinidad, 18, 40; Agate Basin, 19; San Nicolas, 19, 40; Abejas, 21; Coxcatlan, Tilapa, 21, 40; Zacatenco, 26; Palmillas, Tehuacan, Teotihúacan, 31; Lerma, 39; Abasolo, Almagre, Flacco, Garyito, Hidalgo, Infiernillo, Nogales, Tortugas, 40

Pokom, Quiché (Guatemala highlands), 37, 52

Polishers, Teotihuacan, 49

Political fission (schismogenesis), 228. *See also* Cuicatec political fission

Polynesian complex, 60

Pomar relación, 222

Pompa y Pompa, 162

Ponce period (Panuco), 43

Popoloca, *see* Chocho-Popoloca

Population: late Santa Maria, 95; Venta Salada, 125; late Ajalpan to Palo Blanco, 151; and irrigation, 197–198, 246; density, in hydraulic societies, 75, 79; density, Cuicatec, 241. *See also* Cuicatec population

Postclassic period(s), 211, 212, 213, 218; linking traits, 52; urban centers, 237

Pottery: appearance of, 25, 41, 54; sequences, 25; from Purron Dam, 93, 94; Venta Salada, Xiquila settlements, 110; Mixtec tradition in Cuicatec region, 212, 213; Coxcatlan trade with Cuicatec, 213; Cuicatlan, 165

Types: Ajalpan, 25, 26, 28, 42; Altar Fine Orange, 52; Balancum, 52; Canoas, 43, 93; Cerro de las Mesas Polychrome, 53; Cerro del Tepalcate Punctate, 46; Chalahuites, 46; Chila White, 45, 46; Cholula, 52, 53; Coatepec, 26, 28, 45, 46, 93, 94; Coton Grooved Red, 42; Coxcatlan, 31, 94, 97, 136; Dili, 44; Dos Arroyos Polychrome, 50; El Riego, 31, 47, 48, 49, 93, 94; Escalera Orange, 44; Hard buff, 45; Huasteca Black-on-white, 53; Isla de Sacrificios Polychrome, 53; Ixcanrio Orange, 50; Kaolin White, 43, 45; La Venta White Raspada, 43; Loma del Tepalcate Punctate, 46; Mapache Redrimmed, 42; Mars Orange, 44–45, 47; Mixteca polychrome, 53; Monte Alban III Type G., 49; Morelos Lacquer, 45; Ocos Buff, 42; Orange Plain, 49; Ponce Black, 42, 43; Pox, 25, 41; Progreso White, 45; Purron, 25, 41; Quachilco, 46, 93, 94; Ranchito Gray, 46; Rio Salado, 93; San Juan Plumbate, 52; San Martin, 47, 49, 50; stamped-bottom, 212; Tancol polychrome, 53; Tenayuca Black-on-orange, 53; Teotitlan Incised, 97, 136; Tepeu, 50; Texcoco Black-on-red, 53, 94, 97; Thin Orange, 31, 47, 48, 49, 50; Tilapa Red-on-white, 42; Tohil Plumbate, 51; Trapiche Zoned, 43; Tres Zapotes Black Incised, 46; Tula Red-on-orange, 52; Tzakol polychrome, 50; White-slip Red-paste, 43, 45; X Fine Orange, 51–52; Y Fine Orange, 52; Zacatenco, 45

See also Vessels, Wares

Prebish, R., 227

Pre-Iglesia phase (Valley of Mexico), 43

Pre-La Venta phase (southern Veracruz), 42, 44

Prescott, W., 64

Priest caste, Egyptian, 78

Priests, Spanish, 225; in an irrigation society, 246. *See also* Cuicatec priesthood

Proto-Mixtec dialect, 216

Providencia phase (Guatemala highlands), 45

Puebla: relationships, 39, 40, 41; irrigation, 246

Pueblo, 171

Pueblos: hydraulic approach, 60, 64, 66, 79; differentiated analysis, 68; hydraulic-military organization, 70, 71

Puerto Marquez, Guerrero, 34, 41, 42

Pul Eliya irrigation society, 194

Purron Cave (Tc 272), 9; artifacts, 18, 22, 24, 25, 26, 31; composition of zones, 18, 21, 22–26 *passim*, 30; contemporaneity of zones, 18, 21, 24, 26, 29; early El Riego occupation, 18; Coxcatlan occupation, 21, 22; Abejas occupation, 22–24; Purron occupation, 24–25; early Ajalpan occupation, 24–25, 26; early Santa Maria occupation, 29, 30, 44; late Santa Maria occupation, 30, 44, 95; early Palo Blanco occupation, 31, 96; late Palo Blanco occupation, 31, 96; burial, 21; and ceramics, 24, 25, 94; sample dates, 21, 22, 24, 25, 26, 41; dates on zones, 23, 24, 25, 26, 30, 41, 42, 46, 93, 95; plant remains, 93, 94; subsistence, 94; maize, 95; and Purron Dam complex, 82, 92, 93–96 *passim*; Zone U, 18; Zone T, 18, 23; Zone S, 18; Zone R, 18; Zone Q, 21, 23; Zone Q^1, 21, 22, 23, 41; Zone P, 21; Zone O, 21; Zone N, 22, 24; Zone N^1, 22, 24; Zone M, 22–24; Zone M^1, 24; Zone L, 23, 24, 25, 53; Zone K, 23, 24, 25, 41, 53, 95; Zone K^1, 23, 24, 25, 41; Zone J, 23, 26, 41–42; Zone I, 29, 30, 93; Zone H, 23, 29, 30, 44, 46, 93; Zone G, 23, 30, 95; Zone F, 31, 94, 96; Zone E, 31, 94, 96; Zone D, 23, 31, 94, 96; Zone C, 31, 94, 96; Zone B, 31, 94, 96; Zone A, 31, 94, 96

Purron Dam, *see* Purron Dam, main structure (Tr 435)

Purron Dam complex, 82–99, 163, 213, 245; map of vicinity, 82; plan of, 87; chronology, 82, 93–94, 102; subsistence, 94, 95; early Santa Maria occupation, 95; late Santa Maria occupation, 95–96; early Palo Blanco occupation, 96; late Palo Blanco occupation, 96–97; early and late Venta Salada occupation, 97; area of cultivation, 83, 99; reservoir capacities, 85–86, 90, 91, 95, 99; and flooding, 87–88, 96; associated pottery and plant remains, 93, 94; manpower estimates, 97–99; abandonment, 91, 94, 96–97, 99

  Features: drainage channels, 83, 92; platform mounds, 83, 88, 96, 97; spillways, 84–85, 88–90, 93–94; retaining walls, 86–87, 91; canals, 90, 91; T-shaped, 90, 91, 93; summit structures, 91–92, 94, 96; terrace walls, 97; uninterpreted structure, 97

  See also Purron Dam sites below

Purron Dam site (Tr 15): chronology, 44, 93–94; identified, 82; construction, 88, 90, 150; spillway, 88–90, 93–94; inundation and abandonment, 91; associated pottery types, 93; function, 95–96, 98; platform mounds, 97

Purron Dam site (Tr 67), 95, 97

Purron Dam, main structure (Tr 435), 76; location, 83; illustrated, 84–85, 87; cross section, 86; plan, 87; erosion of, 92; volume, 97, 98, 100; possible successor to, 97; manpower estimates, 97–99; construction and social organization, 98–99, 150

  Level 1: construction, 83–86; dating, 92–93; manpower estimates, 98; reservoir capacity, 85–86, 99

  Level 2: construction, 86–90; flooding, 87–88; dating, 93–94, 95; reservoir capacity, 90, 95, 99

  Level 3: construction, 90–91; chronology, 94, 95; reservoir capacity, 90, 99

  Level 4: construction, 91; chronology, 94–95; manpower estimates, 98; social organization, 98–99; reservoir capacity, 91, 99

  Level 5: construction, 91–92; chronology, 94; reservoir capacity, 99

Purron Dam site (Tr 449), 95

Purron Dam site (Tr 450), 95

Purron Dam site (Tr 451), 97

Purron Dam site (Tr 452), 95

Purron Dam site (Tr 453), 97

Purron phase: radiocarbon years and sidereal time, 5, 6; chronology, 24–25, 41; sample dates from Tc 272, 23; dates, 34, 41; estimated time span, 24, 25, 41, 42; artifacts, 25; pottery types, 41; relationships, 41; settlement pattern, 150

Pyramid, 26, 30

Qanat systems, Near East, 139–145 *passim*, 149, 152

Quachilco ruin (Tr 218); 9, 25; occupation, 30–31; excavation, 31; pottery types, 31; figurine types, 46; and Ticoman III, 46; and Tres Zapotes, 46; dates, 47, 48; Zone F, 46; Zones C, C^1, 46; Zone B^1, 46; Zone A, 31, 47, 48

Queretaro, 39, 41

Quiotepec, 176, 212, 213, 233; identified, 181–182; glyphs, 181, 185; subject settlements, 182–183; archaeological site, 165, 213; location and irrigation, 195, 211; tribute, 202; chronology, 213; cacique succession, 208, 223; cacique intermarriage, 224; rulers, 233, 254, 255, 257; AGN *Ramos*, 250

Quiotepec-Papalo conflict, 171, 182, 193, 198, 199, 210, 211, 223, 225

Radiocarbon, 32, 37

Radiocarbon chronology project, 3

Radiocarbon dating: background, 4–5, 6; Tehuacan sequence, 5–6 (*see also* names of phases); and sidereal time, 5–6; and Johnson-Willis correction curve, 5, 6; validity of, 5, 7; and archaeological chronology, 6–7, 15; range of error, 7, 13, 53; total dates accepted, 7; dates rejected, 7, 9; sequence of dates, 10–11, 13; and occupation spans, 14–15; laboratory determination of, 14, 15; correlation, 32; selection, 32; continuity of, 53; no. of samples utilized, 53; of travertine, 135

Ranchito collection, 46

Rayo, Cuicatec god, 207

Recibimiento, 182–183

Regions: relationships, 3; correlation of, 32. *See also* names of regions

Reischauer, E. O., and J. K. Fairbank, 60

Relación de Atlatlauca, 221, 225, 227, 236, 253

Relación de Cuicatlan, 215, 219, 230, 253, 255, 256

Relación de Guautla, 257

Relación de Ixcatlan, 253

Relación de Obispados de Oaxaca, 164, 184

Relación de Papalo, 217, 253

Relación de Pomar, 222
Relaciones, Cuicatec, 164, 184, 253
Remojadas Lower phase (Veracruz coast), 47
Repelo complex, 41
Reservoir, Papalo legendary, 178
Reyes, The (1593), 165
Rice cultivation, 168, 189, 194–195
Rickards, C., 165
Ring bases, 48, 49
Rio Calapilla (Rio Hondo), 102, 113
Rio Chiquito, 175–176, 188, 194, 196
Rio Coixtlahuaca (Rio Blanco), 102
Rio Grande, 231, 232; use of waters, 194–195. *See also* Cañada de Cuicatlan
Rio Grande de Tepelmeme, 102
Rio Hondo, 102, 113
Rio Hondo, Oaxaca, 228
Rio Salado, 102, 113, 131, 181, 232
Rio Santo Domingo, 137, 181, 166, 231, 232
Rio Tilapa, 99, 150–151
Rio Tlapaneco, Guerrero, 108
Rio Usila, 231
Rio Verde, 201
Rio Vueltas, 231
Rio Xiquila, 102–104, 107–108, 109, 112–113, 152
Rio Zapotitlan, 113, 131
Rhys-Davids, T. W., 73
Robertson, D., 217
Ruiz phase (Chiapas), 51
Ruling class: Wittfogel theory of, 64–65; Pareto on, 65, 78; Marx on, 78. *See also* Cuicatec caciques, Cuicatec elite

Sahagún, B. de, 207
Sahlins, M. D., 60, 163
Salazar, Juana de, 257
Salinas, Don Francisco de, 219, 254, 255
Salome, Dona Catarina, 223, 224, 225, 254–255, 256
Salt production: Chinese, 74, 79; Cuicatec, 212, 227–228
Salt River Valley, manpower estimates, 98, 112
Salt site (Tr 196), 121
Salt sites, and associated fossil canals, 135
Salt trade, 74; Cuicatec, 205, 212, 213
Samples: analysis and identification, 3, 5–7, 14, 15; and radiocarbon dates, 5, 6, 7; selection, 14, 15; cloth, 31
San Andrés Papalo, Oaxaca, 181
San Andrés scarp, 132
San Andrés Teotilalpan, 184; glyph, 184; name, 200, 204; ceremonial center, 200, 204, 207; mythology, 207; warfare, 209; political fission, 228; archives, 229, 252
San Baltasar site, Hueyatlaco, 39
San Bartolo Atepehuacan, Valley of Mexico, 39
San Diego Chalma, 131, 132, 142
San Felix phase, Altar de Sacrificios (Petén, Guatemala), 35, 47
San Francisco, Don Miguel de, 256
San Francisco Cotahuixtla, 175
San Francisco La Raya, 182–183
San Francisco Llano Tiopa (San Francisco Llano Verde, San Francisco Nogales), 178–179, 201–202, 202–203
San Francisco phase (Guatemala coast), 37, 50
San Gabriel Chilacatla (Chilac, Puebla), 131, 135, 136, 142, 148, 154, 245
San Gabriel Po, Tehuacan, AGN *Ramos*, 251
San Ignacio Mejia, Puebla, 109
San José phase (Oaxaca), 28, 34, 42, 43
San José Miahuatlan, Puebla, 130, 131, 132, 142
San José Tilapa, Puebla, 82, 120
San Juan Coatzospan, 208
San Juan phase (Guatemala), 37, 52
San Juan Quiotepec, 175
San Juan Teotihuacan, 243
San Lorenzo, AGN *Ramos*, 251
San Lorenzo phase (Tamaulipas), 52, 53
San Lorenzo phase (Veracruz), 28, 34, 42, 43, 44
San Lorenzo springs, 128, 131, 132
San Lorenzo Yepaltepec (San Lorenzo Papalo), 205; colonization of, 171, 211, 218, 254; conflict over water rights, 171, 193, 198, 199, 223, 225, 228, 232; identified, 178; cacique succession claim, 198, 219, 222–223, 224, 225, 254–255, 255–256; settlement pattern, 200, 201–202, 232; land control, 201–202, 202–203, 204, 211; AGN *Ramos*, 251; mythical founder, 254
San Marcos Necoxtla, Puebla, 130, 131; 132, 135, 148
San Marcos Cave (Tc 254), 9; artifacts, 21, 22, 24, 26, 31; composition of zones, 21, 26, 31; contemporaneity of zones, 21, 22, 24, 27, 28; Coxcatlan occupation, 21; early Abejas occupation, 22, 24; late Ajalpan occupation, 26, 27–28; late Palo Blanco occupation, 31; early Venta Salada ocupation, 32; sample dates, 23, 24, 31; dates on zones, 21, 22, 24, 26, 28; maize, 21; pottery types and Purron Dam, 94; and plant remains, 114, 116; Zone F, 21; Zone E, 21, 23; Zone D, 22, 23, 24; Zone C, 23, 26, 27, 28; Zone C^1, 26, 31; Zone B, 23, 31, 94; Zone A, 32
San Martin Xocotepec, 175
San Miguel Santa Flor, 228, 229, 232
San Nicolas cave (Queretaro), 39, 41
San Pablo Tepetzingo, Puebla, 131
San Pedro, 183
San Pedro Chicozapotes, Oaxaca, 171, 176, 177, 185
San Pedro Cuyaltepec, Oaxaca, 180–181
San Pedro Teutila, Oaxaca, *see* Teutila
San Sebastian Tlacolula, Oaxaca, 181
San Sebastian Zinacatepec, Puebla, 130, 142, 148
Sanders, W. T., and B. J. Price, 61, 68, 243, 245
Santa Ana, 242
Santa Ana Teloxtoc, 102, 114
Santa Clara phase (Guatemala highlands), 36, 48
Santa Maria (Santa Maria Tecomavaca, Oaxaca), 183
Santa Maria Coapan, Puebla, 131, 132
Santa Maria Ixcatlan, 253
Santa Maria Nativitas, Puebla, 131
Santa Maria Papalo, Oaxaca, 169, 177, 179, 180, 181
Santa Maria phase: radiocarbon years and sidereal time, 5, 6; chronology, 28–31; beginning date, 28; seriation, 25; sample dates, 17, 23, 29, 30; transition date, 28, 30, 44; pottery, 43, 44, 93; and Purron Dam complex, 93–96 *passim*; irrigation and settlement pattern, 150
  Early subphase: dates, 34–35; estimated time span, 44, 45; pottery, 43, 44, 93; figurines, 44; trade wares, 43, 45; chronology, 43–44; relationships, 44–45; and Purron Dam complex
  Late subphase: artifacts, 30; dates, 31, 35–36, 45–46, 47; estimated time span, 31, 46, 47; pottery, 46; trade wares, 46–47; relationships, 45–47; and Purron Dam complex, 94, 95–96
Santa Maria Tequisquitla, AGN *Ramos*, 251

Santa Marta Cave (Chiapas), 40, 42, 48; dates, 33
Santiago Dominguillo, Oaxaca, 171, 173, 175
Santiago Nacaltepec, Oaxaca, 175
Santiago Quiotepec, *see* Quiotepec
Sapotes: remains, 93, 94, 95; cultivation, 102
Sauer, C., 244
Saws, 26
Schismogenesis, 228. *See also* Cuicatec political fission
Scott, J., 81
Scrapers and scraper planes, 39, 40
Seka-subak, Balinese, 191–192
Selden Roll, 214, 215
Seler-Sachs, C., 165
Settlement patterns: and Purron Dam complex, 94–97 *passim*; Tr 296, 109, 110–111; Xiquila, 112; Venta Salada, 125; Abejas to Santa Maria, 150; dual-division, 202; Mesoamerican, 202, 232. *See also* Cuicatec settlement pattern, Cuicatec setttlements
Shells, 39, 45, 49
Sidereal time, 5, 6
Side-scrapers, 39, 40
Sierra Madre, 50
Sierra Mazateca, 83
Sierra de Tamaulipas, 39, 41
Simpson, L. B., 244
Sinhalese kingdom, 59
Site Tr 5 (salt site), 135
Site Tr 15, *see* Purron Dam site (Tr 15)
Site Tr 20 (hillside system), 114, 116
Site Tr 28 (salt site), 135
Site Tc 35e, w (El Riego Cave), *see* El Riego Cave (Tc 35e, w)
Site Tc 50 (Coxcatlan Cave), *see* Coxcatlan Cave (Tc 50)
Site Tc 51 (Coxcatlan Terrace), *see* Coxcatlan Terrace (Ts 51)
Site Tr 57, 135
Site Tr 62 (Coxcatlan Ruin), 32, 94
Site Tr 65, 32, 94
Site Tr 67 (Purron Dam site), 95, 97
Site Tr 73 – Site Tr 77, 96
Site Tr 78, 96, 97
Site Tr 79, 96
Site Tr 80, Tr 82, Tr 83, 97
Site Tr 84, 96
Site Tr 85, 97
Site Tr 86 (hillside system), 115
Site Tr 92, 96
Site Tr 94, Tr 95, Tr 97, Tr 98, 97
Site Tr 99 – Site Tr 106, 96
Site Tr 109, 96
Site Tr 111 (valley system), 120–121, 124
Site Tr 113 (hillside system), 115, 116
Site Tr 115 (hillside system), 115, 116
Site Tr 132, 96
Site Tr 164 (hillside system), 115
Site Tr 172 (valley system), 121, 124
Site Tr 196 (salt site), 121
Site Tr 197 (valley system), 121, 124
Site Ts 204 (Ajalpan), *see* Ajalpan sites Ts 204, Ts 204D, Ts 204C
Site Tr 210, 52
Site Tr 214, 135
Site Tr 216 (hilltop), 135
Site Tr 218 (Quachilco), *see* Quachilco ruin (Tr 218)
Site 240, 135
Site Tc 254 (San Marcos Cave), *see* San Marcos Cave (Tc 254)
Site Tc 255 (Tecorral Cave), *see* Tecorral Cave (Tc 255)
Site Tr 254, Tr 255, Tr 257, Tr 258, Tr 260, Tr 261 (hillside systems), 116
Site Tc 272 (Purron Cave), *see* Purron Cave (Tc 272)
Site Tr 275 (hillside system), 116
Site Tr 296, 109, 110, 111, 112
Site Tc 307 (Abejas Cave), *see* Abejas Cave (Tc 307)
Site Tr 310 (hillside system), 116
Site Tr 313 (valley system), 117–119, 124
Site Tr 314 (valley system), 116–117, 119, 124
Site Tr 315 (hillside system), 116
Site Tr 316 (hillside system), 116
Site Tr 317 (valley system), 119–120, 124
Site Tr 318 (hillside system), 116
Site Tr 321 (hillside system), 114, 116
Site Tr 322 (hillside system), 114, 115, 116
Site Tr 323 (hillside system), 116
Site Tr 324 (hillside system), 116
Site Tr 326 (valley system), 121, 124
Site Tr 327 (valley system), 121, 124
Site Tr 329 (hillside system), 116
Site Tr 330 (valley system), 119, 120, 124
eSit Tr 332 (hillside system), 114, 116
Site Tr 334 – Site 337 (hillside systems), 116
Site Tr 340 – Site Tr 343 (valley systems), 102, 121, 124
Site Tr 344 (hillside system), 116
Site Tr 346 (valley system), 121, 124
Site 350 (hillside system), 116
Site Ts 367 (Las Canoas), *see* Las Canoas site (Ts 367)
Site Ts 368e, w (Coatepec), *see* Coatepec site (Ts 368e, w)
Site Ts 381 (Chilac), *see* Chilac site (Ts 381)
Site Tr 405, 105, 108, 110–111
Site Tr 411, 105, 108, 111
Site Tr 412, 108, 109, 111
Site Tr 413, 105, 108, 109–110
Site Tr 414 (valley system), 120, 124
Site Tr 415 (hillside system), 114, 116
Site Tr 416, 105–106, 108, 109, 110, 111
Site Tr 417, 108, 109, 110
Site Tr 418 (valley system), 120, 121, 124
Site Tr 419, 110
Site Tr 420, 106, 110
Site Tr 421, 106, 110
Site Tr 422, 110
Site Tr 423 (valley system), 102, 121, 123, 124
Site Tr 424 (valley system), 102, 124
Site Tr 430 – Site Tr 432 (valley systems), 121
Site Tr 433 (hillside system), 113
Site Tr 435, *see* Purron Dam, main structure (Tr 435)
Site Tr 446 (dam), 101–102
Site Tr 447 (dam), 100–101, 102, 115, 151
Site Tr 449, 95
Site Tr 450, 95
Site Tr 451, 97
Site Tr 452, 95
Site Tr 453, 97
Site Tr 454, 135
Sjoberg, G., 234

Small Point complex, 37
Smith, A., 62
Smith, C. E., 135
Sociedades de aguas, 144, 149
Soil Conservation Service, 132
Soncautla (Veracruz), 52
Sonjo village irrigation, 60, 71
Sonora manpower estimates, 98
Soquiapa (Soquiapan, Oaxaca), 174, 175
Southworth, C. H., 98, 112
Spanish language group, 166
Spanish conquistadores, 225
Spanish rights and privileges, 203–204, 219, 224, 225–226, 230
Spanish titles, 171, 173, 218–219, 221
Spanish tribute, 197–198
Spanish tribute grants (*tasaciones*), 219, 224, 225–226
Spindle whorls, 49, 52
Spokeshaves, 40
Spout handles, 48
Springs: Xiquila, 103; Tehuacan Valley, 127, 129, 131, 132, 136, 139; and chain wells, 140; use in late Palo Blanco, 152
Spores, R., 223, 238, 244
Squash, 116, 150
Squier, R., 42
Stelas, 46, 50, 52
Steward, J., 60, 65
Stratigraphy, 7, 9; sequence, 9; and radiocarbon dates, 15
Stuiver, M., 5
Subsistence: and Purron Dam complex, 93, 94, 95; Tecorral canyon, 116; from field systems, 125. *See also* Agriculture
Suchiapa phase (Chiapas), 51
Sugar cane cultivation, 99, 11, 168, 194, 196, 230
Sujeto, 171
Sumer, 61, 72, 73, 74
Supports, *see* Feet types
Swadesh, M., 217

Tabasco, 51
Tajin II, III (Veracruz), 50, 52
Tamaulipas, 39, 40, 41, 50, 52, 53
Tampico-Panuco region, 53
Tamuin, Huasteca, 53
Tanganyika, 60
Tarascans, 241
Tasaciones, 219, 224, 225–226
Tecalote Cave, Hidalgo, 40
Tecazco, 183
Tecoatle, 127, 130
Tecohtoztli, 255, 256
Tecolotlan (Los Cues), 211
Tecomaltianguisco, Oaxaca, 179, 218, 223, 225, 254, 255
Tecomavaca *provincia*, 171
Tecomavaca-Salado, 181, 182, 211, 213, 223, 251, 254, 255
Tecomaxtlahuaca, 190
Tecorral canyon, 100, 101, 114–115, 116, 125
Tecorral Cave (Tc 255), 9; Zone C El Riego occupation, 18; Zone B Palo Blanco occupation, 31
Tecuantecotle, cacique, 256
Tecuhtochtli, cacique, 255, 257
Tecuicuilco, 174, 175, 208–212 *passim*
Tehuacan city, 148
Tehuacan mineral waters, 128, 140
Tehuacan water conflicts, 234
Tehuacan, AGN *Ramos*, 251
Tehuacan Archaeological-Botanical Project, 3, 61, 81, 163
Tehuacan sequence, 3, 9, 81; radiocarbon years and sidereal time tabulated, 5–6; computer analysis, 13; correlation of, 32; occupation spans, 32; dated components, 53; time span, 53
Tehuacan tombs, *see* Tombs
Tehuacan Valley: hydraulic pattern, 76; population increase, 95, 125, 151; springs, 103, 127–129, 131, 132, 136, 139, 140, 152; mineral waters, 128, 140; water supply today, 140–141; water table, 137, 139, 140, 142, 147; water requirements, 101; hydrology, 127–129, 142, 148; irrigated farming, 125–126; canal irrigation, 130; and the Cuicatec region, 212–214, 230–231; salt production, 227; archaeological irrigation, 245
Tehuacan-Cuicatlan basin, 137
Teloxtoc, Puebla, 102, 114
Temple of the Sun, Teotihuacan, 43
Tenayuca, 53
Tenochtitlan, 205, 211, 218, 225, 227, 243
Teotihuacan (Valley of Mexico), 234, 237, 243; dates, 43; related phases, 47, 48, 49; hydraulic approach to, 61, 68, 76; monumental architecture, 99; water scarcity and control, 199, 203; irrigation, 245, 246; vessels, 49, 50
Teotilalpan, *see* San Andrés Teotilalpan
Teotitlan, *see* Teutila
Teotitlan del Camino, 168, 177, 120, 142, 209, 211, 212, 213, 227, 245
Teotitlan *provincia*, 171
Tepetate, 133, 135
Tepetzingo, 131
Tepeu phases (Petén, Guatemala), 36, 50, 52
Tepeucila, 173, 230; geography, 171, 177, 185; identified, 179–180; glyphs, 180, 185; subject settlements, 180–181, 202; population, 196, 197–198; tributary, 196, 197–198, 209; settlement pattern, 200, 201, 202; trade, 205; salt, 205, 212, 227; elite descent lines, 206, 217–218, 220; date of foundation, 218; rulers, 219, 223, 254, 255; AGN *Ramos*, 249, 250
Tepeucila-Quiotepec, AGN *Ramos*, 252
Teponapa, 179, 219, 223, 254
Teponaxtla, AGN *Ramos*, 181, 251
Tequelite spring, 103
Tequisquitla, AGN *Ramos*, 251
Terracing, 113–125 *passim*, 133, 151–152, 181
Tetela Cave, Puebla, 40, 41
Teutila (San Pedro Teutila), 177, 180, 213; identified, 183–184; glyphs, 183; economy, 185; ceremonial center, 200; tributary, 209; caciques, 224, 254; AGN *Ramos*, 249, 250, 252
Teutila-Chiquihuitlan-Tlalixtac, AGN *Ramos*, 252
Teutli (mythical ancestor), 217, 254
Texcala, Puebla, 113
Texcalli springs, 128, 136, 139
Texcoco, 218
Tezcatlipoca, military god, 237
Tezoyuca phase (Valley of Mexico), 46
Tibet, 60
Tico, 255
Ticoman phases (Valley of Mexico), 35, 46
Tikal sequence (Petén, Guatemala), 44–45, 47, 48, 50, 51
Tilapa canyon, 96, 97, 99, 150–151
Tilaltongo, 175, 214, 219

Time markers, 21, 28, 49, 51
Tiñana, cacique, 256
Tiquisate phase (Guatemala coast), 50
Tizoc, 209
Tlachic huya (San Pedro Cuyaltepec, Oaxaca), 180–181
Tlacoatzintepec, 209, 212
Tlacolula (San Sebastian Tlacolula, Oaxaca), 181
Tlacolula-Yagul, Oaxaca, 181
Tlailotlaques, 218
Tlalixtac, Oaxaca, 177
Tlaloc, Cuicatec god, 188, 207, 227, 237
Tlalpan complex (Valley of Mexico), 43
Tlamimilolpa phase (Valley of Mexico), 36, 48
Tlapacoya (Valley of Mexico), 39, 43
Tlatelolco, 219, 255
Tlatilco (Valley of Mexico): mottled bottles, 42–43, 45; burials, 43; relationships, 43, 45; wares and pottery, 45
Tlaxcalans, 244
Tlaxcaltecans, 241
Tlecuaco, 183
Tohil phase (Guatemala highlands), 37
Tolstoy, P., 43
Toltec, 214
Tomas de agua, 188
Tomato cultivation, 168, 189, 195
Tombs: Tehuacan, 49; Yucuñadahui, 49; Laguna IX, 50; Esperanza and Aurora, 50; VIII, 51
Tomellin, Oaxaca, 188
Tonaltepec, 175, 208, 209, 233; salt trade, 205; AGN *Ramos*, 249; cacique, 257
Totolica phase (Valley of Mexico), 35, 43, 45
Totonac, 125, 244
Toxtecutli, Don Lorenzo, 219, 223, 225, 254
Toxtecutli, Don Martin, 223, 225, 254, 255
Trade: hydraulic societies, 74; irrigation societies, 246; Cuicatec, 205, 212, 213, 227
Trade wares: correlation of, 32; use in chronology, 53–54
Trapiche I, II, III (Veracruz), 42, 43, 44, 46
Travertine: canal deposits, 128–129, 133–135; radiocarbon dating, 135; cleaning, 136–137; chain well deposits, 147; field borders, 131
Tres Zapotes (southern Veracruz), 35, 46
Tula, 214, 218, 239
Tule Springs, Nevada, 135
Turney-High, H. H., 70
Tutepetongo (Tututepetongo), 173; geography, 171, 177; glyphs, 172, 185–186; identified, 175; Mixtec subject, 175, 177, 208, 209, 233, 236; cotton trade, 205; rulers, 236, 256, 257; AGN *Ramos*, 249, 250, 251, 252
Tututepec, 175
Tuxtepec, 209
Tuxtepec Paper Co., 168
Tuxtla (Chiapas), 53
Tzacualli phase, Teotihuacan (Valley of Mexico), 36, 47, 48
Tzakol I, II, III, Uaxactun (Petén, Guatemala), 36, 48, 50
Tzec phase, Tikal (Petén, Guatemala), 35, 44–45, 47
Tzinacantepec (Chiquihuitlan, Oaxaca), 183

Uaxactun sequence (Petén, Guatemala), 44–45, 47, 48, 50, 51
Ulapa (Chapulapa, Oaxaca), 171, 177, 179, 213, 228
Urban centers, 54, 237, 246
Urbina (Chiapas), 53
Usila, 184
Usulutan wares, 47
Uxmal structures, manpower estimates, 98

Valencia, water control, 233
Valerio Trujano, *see* Güendulain
Valley field systems, 113, 116–125; chronology, 124, 125
Valley of Mexico, *see* Mexico, Valley of
Valley of Oaxaca, *see* Oaxaca, Valley of
Valsequillo, Puebla, 39
Vansina, J., 165, 214
Venta Salada phase: radiocarbon years and sidereal time, 5, 6; chronology, 31–32; sample dates from Tc 50, 17; and Purron Dam complex, 94, 102; Xiquila settlements, 109, 110–111; fossil canal system, 135–139; chain well deposits, 148; irrigation agriculture, 152
  Early subphase: dates, 37, 51; estimated time span, 51, 52; components, 51; relationships, 51–52; Lencho Diego occupation, 97; Tecorral canyon occupation, 114, 116, 120, 121, 122, 124, 125
  Late subphase: dates, 37; estimated time span, 51, 53; relationships, 53; Lencho Diego occupation, 97; Tecorral canyon occupation, 115, 116, 117, 120, 121–122, 124, 125; settlement, 128, 131
Veracruz: pottery types and dates correlated, 28; central, relationships, 42, 43, 44, 50–53 *passim*; northern, relationships, 53; southern, relationships, 42, 44, 46, 47, 51, 52, 53; Cuicatec trade with, 212
Verbitsky, M. E., 253
Vessels: early Palo Blanco and related, 48; early Venta Salada, 52; time markers, 49; Teotihuacan, 49, 50. *See also* types of vessels, Pottery, Wares
Vietnam, hydraulic approach, 59–60
Villages: development of, 54; Asiatic, 63. *See also* Settlement patterns
Vlapa, *see* Ulapa

Walnut cultivation, 195
Wares: Coatepec, 26, 28, 45, 46; zoned decorated, 42; white, 45, 46; raspada, 45, 46; gray, 46, 47, 49; Ticoman I–III, 46; Usulutan, 47; engraved decorated, 48; carved decorated, 48, 49; fresco-decorated, 49; Tzakol, 50; Zaquil, 50; fine-line decorated, 52; *fondo sellado*, 52; red-on-orange, 52; Teotihuacan, 49, 50; stamped bottom, 52, 212; Aztec trade, 53. *See also* Pottery, Vessels
Warfare: organization of, 70, 79; Aztec, 183, 208, 209, 234, 242, 254; Mixtec, 208–212 *passim*, 233; Zapotec, 174, 208, 209, 212; Postclassic Mesoamerican, 211. *See also* Cuicatec warfare, Cuicatec water wars
Water control, 234–235. *See also* Irrigation
Water cooperatives, 191–192
Weber, Max, 65, 70, 78
Weitlaner, R., 162, 164, 165, 208, 212, 253
Wittfogel, K. A.: theory of ruling class, 64–65; "Theory of Oriental Society," 65–66; "dynastic cycle," 66, 79; on ancient Mesoamerican hydraulic societies, 66–68; on role of elite in centralization of authority, 192; theory on Mesoamerican irrigation society, 163, 242–243; hypothesis on water control, 244, 245
Wood idol, 49

Woodbury, Nathalie F. S., 82

Xayacatlan (Jayacatlan, Oaxaca), 172, 174, 186
Xe phase, Altar de Sacrificios (Petén, Guatemala), 35, 44
Xicotenantli Tlamaca, 211
Xikioci, Cuicatec god, 207
Ximenez, Don Diego, 222, 225, 254, 255, 256
Xiquila Aqueduct, 102–113; illustrated, 104, 105, 106; discovery of, 104; channel path, 104–106, 110; higher channel, 105, 107, 109; features, 104–106; elevation, 105, 108; dimensions, 106, 108; diversion dam, 107–108; and associated aqueducts, 108–109; and associated sites, 109–111; chronology, 109; area cultivated, 111–112; manpower estimates, 112; use in Palo Blanco and early Venta Salada, 152
Xixichutecutli, Don Juan, 254, 255
Xnaghanihina, 255
Xocoyoltepec, 176, 177
Xolalpan phase (Valley of Mexico), 36, 48, 49, 50
Xolotl, 218
Xoxotepeque, *see* San Francisco Llano Tiopa
Xuchiltlapano, Don Juan (El Roto), 255

Yanhuitlan, 174, 176, 208, 209, 244
Yepaltepec, *see* San Lorenzo Yepaltepec
Yolox, 173, 175, 212
Yolutla (El Coyul?), 180
Ysapa, 174
Yucatan, 50, 51, 52, 66, 98
Yuto-Aztecan dialect, 217
Yztecutli Ditonidona, 219, 223, 254, 256

Zacatenco (Valley of Mexico), 35, 45, 46
Zapotec: language group, 166, 169, 232; warfare, 174, 208, 209, 212; elite intermarriage, 224, 241
Zapotitlan, 179, 223, 254; valley irrigation, 102, 116–124
Zaquil phase (Panuco), 49, 50, 52
Zinacatepec, 130, 142, 148
Zones: deposition of, 9, 14; sequence of dated, 9, 10–11, 13; chronology of, 12, 13, 16; linear arrangement, 13; determination of occupation span, 14, 32; alignment of surface, 32. *See also* under names of sites
Zoquiapa, 174–175

(Continued from front flap)

Chilacatla." This short history was written down in 1962 by Sr. Gorgonio Gil Huerta from the oral and archival traditions surviving in the present town of Chilac. Sr. Gil is a resident of Tehuacan. The history was published in Volume 5 of *Tlalocan* and has been translated by James A. Neely for inclusion here.

Dr. Eva Hunt's work is an ethnohistory of the Cuicatec, a contemporary irrigation society located in a linguistically and geographically bounded area at the south end of the Tehuacan Valley. The social system and irrigation system of the Cuicatec is analogous to Tehuacan and sheds light on the whole question of the social role of ancient and modern irrigation in Mesoamerica. A comprehensive study of sixteenth-century primary sources documents the field work carried on in 1963 by the author and her husband, Robert Hunt. Accompanying this chapter are codices drawings, maps, and genealogy chart and appendix.

Other volumes in this series include:

Environment and Subsistence, a description of the environment and of the complete development of the subsistence from food gathering to agricultural production. Volume I, $15.00.

Nonceramic Artifacts, a discussion of stone implements, cordage, netting, basketry, sandals, textiles, and various artifacts of materials other than pottery. Volume II, $12.50

Ceramics, an extensive analysis of about 500,000 potsherds from 218 excavated sites and 454 survey sites, beginning with the first appearance of pottery in the valley ca. 2300 B.C. Volume III, $15.00.

Excavations and Reconnaissance, thorough descriptions and theoretical reconstructions of the prehistoric occupations of the many components of the Tehuacan Valley. Volume V, in preparation.

The Dawn of Civilization, a summary of developing culture in the Tehuacan Valley and related regions of Middle America. Volume VI, in preparation.

The entire series is edited at the R. S. Peabody Foundation for Archaeology, Phillips Academy, Andover, Massachusetts. The Foundation was previously directed by Douglas S. Byers (now retired), who served as General Editor of Volumes I and II. Richard S. MacNeish, present director and General Editor of the Series, headed the Tehuacan Archaeological-Botanical Project of 1961-1964.

UNIVERSITY OF TEXAS PRESS
AUSTIN AND LONDON

Printed in U.S.A.

ISBN 0-292-70155-1

From the reviews of previously published volumes:

"These two volumes are the first in what is surely a landmark in the history of New World archaeology. . . . Possibly only for the Near East do we now have such a clear picture of that very long stage—spanning several millennia—during which man gradually came to produce rather than merely gather his food. . . . Everyone interested in the American Indian, in Mesoamerica, and in the prehistory of the New World should own these beautifully edited and illustrated volumes—not just to decorate a bookshelf but to read and use. The subsequent volumes in the series (to cover ceramics, chronology, and excavations) are eagerly awaited."

—Michael D. Coe in *The Hispanic American Historical Review*

"One of the most important archaeological programs during the last decades in Mesoamerica was the Tehuacan Archaeological-Botanical Project . . . Summarizing the impression given by these two volumes, we may say that they are up to the high standard set by the field investigations. Their content considerably advances our knowledge of the beginning of plant cultivation and the sedentary life in Mesoamerica, as well as of the techniques involved in general."

—Wolfgang Haberland in *Archaeology*

"The two volumes are beautifully presented and illustrated. . . . I can only heartily congratulate MacNeish and his colleagues on having brought about one of the most basic and perfect excavations carried through in Mexico. Their publication is a must. When talking to him or reading his first brief reports, one might think that Richard S. MacNeish is a magician out of whose hat come ideas of prime importance. Nothing could be less correct. What comes out is not the consequence of a magician's trick but the well-pondered results of imagination, knowledge, organization, and hard work."

—Ignacio Bernal in *American Journal of Archaeology*

PUBLISHED FOR THE R. S. PEABODY FOUNDATION FOR ARCHAEOLOGY, PHILLIPS ACADEMY